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The reclassification of material asked for by the contractors of sections C, D, E and F, of the Chicago Drainage Canal has been refused by the Board of Trustees. This action places everything in the hands of the Chief Engineer, who has large discretionary powers in dealing with the contractors, according to the terms of their contracts with the Drainage District. The basis of the contractors' claims for reclassification was that the specifications and such information as was furnished by the Drainage Board gave no indications of the intractable material which was finally encountered, and that the contract prices were less than the cost of excavating this material, so that work was being done at a loss. This material consists of an indurated clay, requiring blasting, and a mixture of boulders and gravel, with deposits of quicksand, to which the name of "conglomerate" has been given, and is estimated to cost from 30% to 50% more to excavate than the contract price. All the contractors, except those on section E, are still at work, but just what they will do in view of the action of the Board of Trustees cannot be told until the Chief Engineer takes action. It should be noted that a minority report, made by two of the eight trustees, favored granting the request of the contractors.

A new water-supply tunnel is to be constructed by the city of Chicago to run from a point near Humboldt Park east into the lake, a distance of four miles. At the meeting of the City Councils, held July 30, the construction of the tunnel was authorized and the City Engineer has been ordered to prepare plans and specifications for the work. The contract for making the necessary borings will be let at once, and work on the tunnel is expected to begin as soon after these are completed as the final corrected plans can be got in shape and the contracts let. The estimated cost of the work, including a 60,000,000-gallon pumping station, is $3,500,000, and it is thought that it will take about three years to complete it. The work will be under the charge of the City Engineer, Samuel G. Artingstall, M. Am. Soc. C. E.

A loop line connecting the elevated railway lines in the business district of Chicago is proposed by the Chicago & Suburban Elevated Electric Ry. Co., which has recently issued a prospectus describing its scheme. According to this prospectus the line will be single track, running from Randolph and State Sts., west on Randolph, south on Market St., east on Jackson St. and north on State St., to the point of beginning. The trains are to be operated by electric power. The total length of the loop will be 2¼ miles. Mr. Benezette Williams, M. Am. Soc. C. E., is interested in the enterprise.

The construction of electric trolley and elevated railway lines in Chicago promises to be very extensive in the next year or two if the various schemes headed by Mr. Chas. T. Yerkes, the well-known street railway magnate, are carried through. The proposed new trolley lines, aggregating about 100 miles, of the West Chicago and North Chicago Street Ry. Co.'s were briefly described in our last issue, and it is now stated that the construction of the main line of the Northwestern Elevated Ry. and the extension of the Lake St. Elevated R. R. will be carried out at the same time. To provide the money necessary for this work three mortgages have been filed with the Illinois Trust & Savings Bank as trustee, aggregating $18,000,000, of which $15,000,000 are secured on the property of the Northwestern Elevated, $1,000,000 on the North Chicago Electric Co. and $2,000,000 on the Chicago Electric Transit Co. In connection with these mortgages Mr. D. H. Louderback, President of the Northwestern Elevated, is reported as saying that the contracts for the construction of the line would be let soon, and also that the $18,000,000 loan was for construction expenses for the lines according to the amounts named in the mortgages on each. He also stated that the building of the line would be undertaken by the Columbia Construction Co., which has been organized with a capitalization of $2,000,000.

The most serious railway accident of the week was a collision between the two sections of a freight train on the Pennsylvania R. R., at Bucyrus, O., Aug. 3. The rear section ran into the forward section when the latter slowed up for a crossing, and several cars were wrecked, including a tank car, which caught fire and four tramps were burned in the wreck.——In a rear collision between a freight and a passenger train on the Baltimore & Ohio Southwestern Ry., at Aurora, Ind., July 30, three men were killed.

Two bridges on the Chicago & Eastern Illinois Ry., near Brazil, Ind., were burned, Aug. 7. Incendiarism is suspected.

The boiler of a Canadian Pacific Ry. locomotive exploded near Field, B. C., July 30, while pushing a freight train on a heavy grade. Two men were killed. ——The boiler of the dredge boat "Philadelphia," of the American Dredging Co., exploded Aug. 7, while the dredge was at work on the Delaware River opposite Camden, N. J. One man was killed and six were injured.

The large artesian well at San Antonio, Tex., noted in our issue of July 26, is 12 ins. in diameter, 630 ft. deep and has a "calculated" flow of 3,400,000 gallons per day. In the above-named issue we stated that the daily flow was reported as 4,200,000 gallons, but that later reports might give a diminished yield. The San Antonio Water-Works Co., to which this well belongs, has three other wells close by, 8 ins. in diameter and from 750 to 800 ft. deep, which yield 1,500,000 gallons per day each. The company also has four other wells in the center of the city, which have a satisfactory flow. We are indebted to Mr. J. Ulrich, Secretary of the Water Co., for the figures given above.

A "reaction scale and general slide rule" has been invented by Mr. W. H. Breithaupt, M. Am. Soc. C. E., and is being manufactured and sold by Mr. E. G. Soltmann, 119 Fulton St., New York city. The instrument consists of a cardboard disk, 14 ins. square, ruled with cross-section lines and traversed by a graduated brass straight-edge hinged at one corner of the card. With this apparatus operations of multiplication and division can be performed as with a slide rule, and the result can be read correctly to three places. The instrument can also be used for finding end reactions due to a concentrated load on a beam, length of sides or hypothenuse of right triangles, and for other purposes.

The statistics of traffic via the Suez canal in 1893 show the passage of 3,341 ships, with a tonnage (net) of 7,659,068, as against 3,557 ships, of 7,712,028 tons, in 1892, and 4,207 ships, of 8,698,777, in 1891. The following table shows the distribution of shipping by nationalities for 1893:

	Ships.	Net tonnage.
English	2,405	5,752,934
German	272	555,750
French	190	461,197
Dutch	178	337,465
Austrian	71	196,779
Italian	67	119,827
Norwegian	40	88,674
Spanish	29	70,600
Russian	24	53,548
Turkish	34	39,601
Portuguese	10	11,309
Egyptian	4	4,441
American	3	3,200
Belgian	1	1,761
Japanese	1	1,280
Brazilian	1	634

There has been a large gain in the tonnage of France, Austria and Russia, a slight loss in that of England, Italy, Norway and Turkey, and a great loss in that of Portugal. Germany shows a slight gain. England carried 75.11%, Germany, 7.26; France, 6.02; Holland, 4.27; Austria, 2.18; Italy, 1.58; Norway, 1.16; Spain, 0.92% of the gross traffic. The number of passengers passing via the canal decreased from 189,800 in 1892 to 180,432 in 1893. Of the passengers 71,880 were soldiers.

A dam across the Kansas River at Muncie, Kan., near Kansas City, Mo., is under consideration. It is reported that water would be used for power and irrigation and that Mr. J. T. Fanning, M. Am. Soc. C. E., of Minneapolis, has been employed as consulting engineer by the projectors.

The New England Meteorological Society is experimenting with tailless Malay kites at the Blue Hill observatory. Experiments made at Bergen Point, in 1893, show that with nine kites, from 2 to 6 ft. in diameter, an altitude of 5,400 ft. can be attained. These kites are flown tandem, one above the other, held by one strong silk line. By using two series of kites an altitude of 10,000 ft. is hoped for in the Blue Hill trials. The ultimate object of the experimenters is to send aloft self-recording meteorological instruments with the purpose of better studying thunder storms and storm movements in the upper air stratn. The "Malay" kites to be used are really devised by Mr. W. A. Eddy, of Bayonne, N. J. They are made with a central upright stick and a cross piece near the top bent and strung like a bow. These sticks are usually the same length, though the exact proportions are very important. For a kite of 1 yd. square, the sticks are ¼ in. square, of spruce or ash. The paper used is strong tissue, wrapped with twine at the ends. The kite string is attached to the intersection of the sticks, and, by a string, a little longer than the longest side of the kite, attached to the lower point of the center stick.

The Central Asian capitals of Samarkand and Bokhara depend for water upon the river Zerafshan. The establishment of Russian towns along the river of late years has practically cut off the water supply to Bokhara, and that town is now pleading for the water which is absolutely necessary for its existence. The Russians now promise to lead to it the waters of the Oxus by a canal through the desert nearly 200 miles long. It is said that the work of construction will soon commence.

The new ocean cable of the Anglo-American Telegraph Co. was completed on July 27, landing at Heart's Content, N. F. The whole cable was laid in 12 days by the cable-ship "Scotia." This new cable lands at Valentia, Ireland, and has a larger conductor than any previous cable laid, containing 600 lbs. of copper to the nautical mile. As this increases the speed of transmission, the new cable has a greater capacity than any of its predecessors. There are now eight Atlantic cables connected with New York.

The shops of the Chicago & Eastern Illinois Ry. at Broughton, Ind., are to be removed to Momence, Ill., on account of the failure of the city and county authorities to afford protection to the company's property and employees during the recent strike.

The electric power plant for operating the Baltimore Belt Ry. tunnel will consist of a battery of eleven boilers of 250 HP. each, furnished with appliances for mechanical draft, the gases being delivered to a 50-ft. steel chimney. The boiler room will be 98 × 60 ft., and will be fitted with automatic coal conveyors. The engine room will be 58 × 240 ft. and will contain four 750-HP. Corliss compound engines coupled direct to four 700-HP. multipolar direct-current generators. These will furnish the current for the tunnel locomotives, and for lighting the tunnel. The locomotives will have two four-wheel trucks and each truck will have two 300-HP. motors. The motors will be carried on springs and will be connected to the driving axles by flexible connections. One of these locomotives is completed and the remaining two are to be ready for service Jan. 1.

Besides the plant above described, the central station will contain four Armington & Sims compound high-speed engines, two of which will be belted to eight 50-arc light machines. The other two will drive generators, furnishing current for 2,000 incandescent lamps, which will light the new depot and other buildings belonging to the company. The power house will be a one-story brick building with granite trimmings. Work is in progress on its foundations.

The natural gas belt of Indiana is being rapidly exhausted, and in a short time will be entirely so, says State Gas Inspector Jordan, of Indiana. Mr. Jordan reports the field as nearly thoroughly occupied and in five or six years more he expects the supply to cease. Already the rock pressure has fallen from 320 to 240 lbs., and hundreds of wells have been abandoned. The Cincinnati "Commercial Gazette," however, denies this statement of Mr. Jordan on the authority of its own investigations, and publishes letters from nine gas centers reporting plenty of gas and little or no reduction of supply.

MECHANICAL STOKERS.

The advantages of using machinery for placing fuel under steam boilers have long been understood in England—mechanical stoking being, in fact, almost coeval with the steam engine*—and there have been many inventions in this direction. English stokers, however, being designed for use on internally fired boilers, were not easily adapted to use on American externally fired boilers, and so, while their use spread into Germany and other Continental countries at an early date, it is only within recent years that they have come into use to any considerable extent in the United States. As the advantages of mechanical stoking come to be better understood, however, and as the rapidly-increasing competition in manufacturing narrowed the margin of waste in the production of power, more serious attention was given to the question of mechanical stoking by American engineers. The result has been the evolution of a number of mechanical stokers possessing several distinct improvements over the best English types, at least in so far as American boiler practice is concerned.

The large number of forms of English mechanical stokers in use precludes even a brief summary in this article.** The most common forms, however, embody the features of throwing or pushing the fuel from the feeding apparatus in the boiler front over the grate by means of shovels actuated by springs or cams, or by rapidly revolving fans, drums or discs, or some form of traveling chain grate, rocking or reciprocating parallel bars, etc. The complicated nature of the mechanism, often subjected to intense heat and obliged to work in coal dust and ashes, renders these devices especially liable to get out of order and costly to maintain. Despite their faults, however, these stokers have shown the great advantages of mechanical over hand stoking, and thousands of them are now used in England.

It is not proposed to discuss here the comparative merits of the different forms of mechanical stokers illustrated, but a brief statement of some of the requisites of an efficient stoker may be made. First of all, such a stoker should be simple in construction and as nearly automatic in operation as possible. With these it must combine efficiency of combustion, adequate grate capacity, durability and smokelessness. To secure efficiency and economy of combustion, it should be capable of burning all grades of bituminous and lignite coal; the grates should be constructed so as to permit the free passage of large quantities of air when required, or to shut it out when not required; and the means for removing the ash and clinker should be easy and rapid and not require the opening of the furnace door. All parts of the furnace should be easily accessible and exchangeable, so that repairs can be easily and quickly made, and their arrangement should be such that the condition of the fire can be observed without opening the doors. The coal magazines and all the mechanism for feeding the furnace should be located so as not to be affected by the heat. It is also desirable that the furnace be constructed so that a system of coal and ash-handling machinery can be applied if desired. It is hardly necessary to say that the ideal stoker has not been realized as yet, but in so far as any stoker at present in use is successful, it embodies the features described.

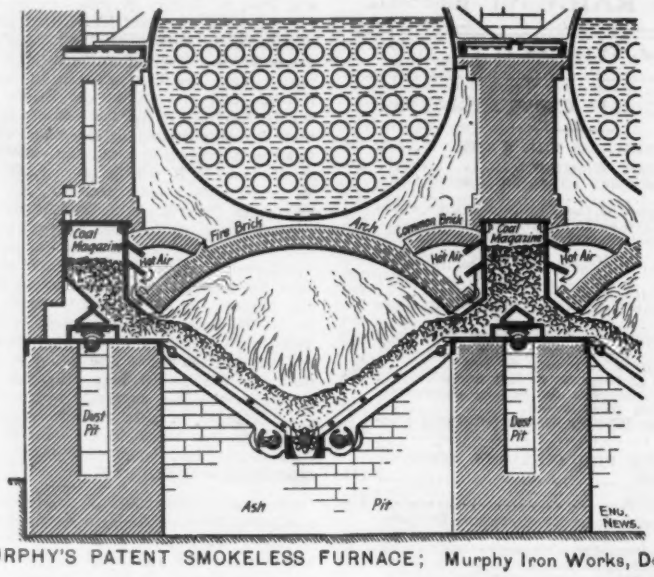


FIG. 1. MURPHY'S PATENT SMOKELESS FURNACE; Murphy Iron Works, Detroit, Mich.

FIG. 2. BRIGHTMAN STOKER APPLIED TO A SAFETY WATER TUBE BOILER; The Brightman Stoker Co., Cleveland, O.

*The earliest form of mechanical stoker of which there is any record was probably the one patented by James Watt in 1785, which was simply a device to push the coal after it was coked at the front end of the grate back toward the bridge. It worked intermittently by levers.

**For a complete history of mechanical stoking in England see "The Steam Engine," by Mr. D. K. Clarke (Blackie & Son, London, 1890), and for a more brief summary of English stokers, see paper by Mr. Wm. R. Roney, Trans. Am. Soc. M. E., vol. XII., p. 921.

Murphy Patent Furnace.—The first distinctively American mechanical stoker was not invented until 1878, when Mr. Thomas Murphy, of Detroit, Mich., brought out the Murphy patent furnace, adapted to externally-fired boilers only. A sectional view of this furnace is shown in Fig. 1. Two coal magazines are placed in the side walls of the furnace and extend back from the boiler front 6 or 7 ft. In the bottoms of these magazines are placed rec-

tangular boxes, so connected with a rack and pinion, operated by a small engine, that they move from side to side every 6, 10 or 15 minutes, pushing the coal upon the grates, which incline from the inner edge of the magazines to the center, forming a V-shaped receptacle for the burning coal. On the top of the rectangular box is a triangular box, which can be moved longitudinally, serving to divide the coal and deflect it toward the grates. The grates are composed of narrow parallel bars, so arranged that each alternate bar shifts about 1 in. at the lower end. In the space between the lower ends of the grate is a cast iron toothed bar, turned by a crank, for the purpose of grinding the clinker.

Over the V-shaped trough is sprung a brick arch, extending about one-third the length of the boiler and resting on an iron arch plate, with ribs about an inch apart to provide for the free circulation of air at the abutments. Air is admitted in front of the furnace and passes up through a flue in the brick wall, then over the arch, there takes up heat from the brickwork, passes down the haunches of the arch to the little openings and through them to the coking fuel. By the time the air has reached this point it is sufficiently hot to ignite the gas from the green fuel, so that when the coal reaches the grate the bituminous part has been consumed and only the coke remains, and this gets its needed supply of air through the grates. A bituminous coking coal is best suited to this furnace.

Efficiency.—Evaporative tests of the Murphy furnace made at the Holly Steam Combination Co.'s boiler plant, at Lockport, N. Y., in 1884, showed the following results:

Kind of furnace ..... Kind of fuel..	Murphy Gas coal	Murphy Soft slack	Murphy Hard and soft slack	Common Loyal-sock	Pierce Naphtha
Cost of fuel, per ton	$2.85	$2.05	$2.00	$2.00	$1 bbl.
Pounds water evap. per 1 lb. coal	9.01	8.02	8.33	7.09	14.17
Cost to evap. 1 ton water, cts.	32	25	24	38	64

According to these figures the percentage of economy of the Murphy over the common grate furnace in pounds of water evaporated per pound of coal was 13% for soft slack and 27% for gas coal. It should be noted that the figures in the table denote the actual evaporation. A similar comparative test of a Murphy and common furnace made at the works of the Brush Electric Co., Cleveland, Ohio, in 1884, showed a percentage of economy for the Murphy furnace of 25.7% in pounds of water evaporated from and at 212° F. per lb. of coal. The economy was slightly greater per pound of combustible. The amounts of coal consumed per square foot of grate per hour were respectively 18.6 lbs. and 30.9 lbs., and the evaporative rapidity 3.07 lbs. and 2.81 lbs. respectively of water evaporated per square foot of heating surface per hour. Tests made at the Cincinnati Industrial Exhibition in 1879 showed the furnace to be practically smokeless, the intense heat maintained by the long brick arch preventing the escape of any unconsumed gases.

Brightman Mechanical Stoker.—The Brightman mechanical stoker was patented in 1885. Fig. 2 shows its application to a water tube boiler. The coal magazine or hopper runs transversely across the front of the boiler, and holds from two to twelve bushels of fuel. A cast iron feed table forms the bottom of the hopper and extends inside the furnace to the top of the grate, which is inclined at an angle of 34° to the back of the furnace. A metal pusher, working back and forth on the feed table, pushes the coal onto the grate at regular intervals, the number of movements being regulated to suit the conditions.

The grate bars are made with lateral projecting lugs, as shown in the accompanying sketch, Fig. 3. The lugs of each bar mesh, so to speak, with those of the neighboring bars and each alternate bar has a reciprocating motion. By this construction there are no vertical openings for the escape of fine coal, but there are ample horizontal openings for the air. The movement of the burning coal down the grate to the horizontal grate over the ash pit will be readily comprehended. The mechanism for operating the various parts may be operated from a convenient shaft or by an independent engine.

Efficiency.—The claim is made by the manufacturers that the Brightman stoker will supply more steam, using bituminous slack, than the flat grate furnaces commonly used produce from lump coal, the boilers and other accessories being the same, and, in addition, will require but one-half the operating force and will produce no smoke. Three evaporative tests made at the mills of the Cleveland Paper Co., Cleveland, Ohio, showed an average rate of evaporation of 11.32 lbs. of water per pound of combustible, slack coal being used having

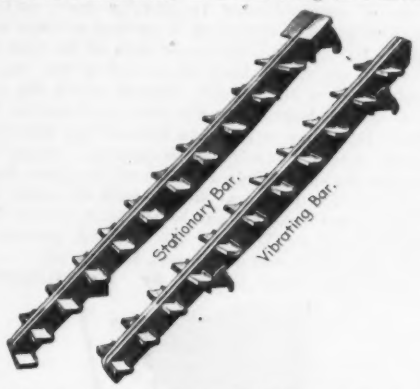


Fig. 3. Grate Bars for Brightman Furnace.

about 15% ash. A test made at the W. S. Tyler Wire Works, Cleveland, Ohio, in 1887, showed the following results:

Kind of fuel .....Massillon coal slack.
P. c. refuse..... 9.872
Water evap. per lb. coal from and at 212°.... 10.75 lbs.
Water evap.per lb. combust.from and at 212° 11.93 "

The above test was made while the boiler was performing its regular daily duty. There was but a slight trace of smoke at the chimney head.

Roney Mechanical Stoker.—The Roney mechanical stoker is the invention of Mr. William R. Roney, M. Am. Soc. M. E., and was patented in 1885. The general construction of this stoker is shown in Fig. 4. As in the Brightman stoker, the hopper extends transversely across the front of the furnace and is provided with a "pusher" to push the fuel in onto the grate bars. The grate consists of horizontal flat-surfaced bars, reaching from side to side of the furnace, carried on inclined side bearers extending from the throat of the hopper to the rear and bottom of the ash pit. The grate bars, therefore, in their normal position form a series of steps, to the top step of which coal is fed from the hopper.

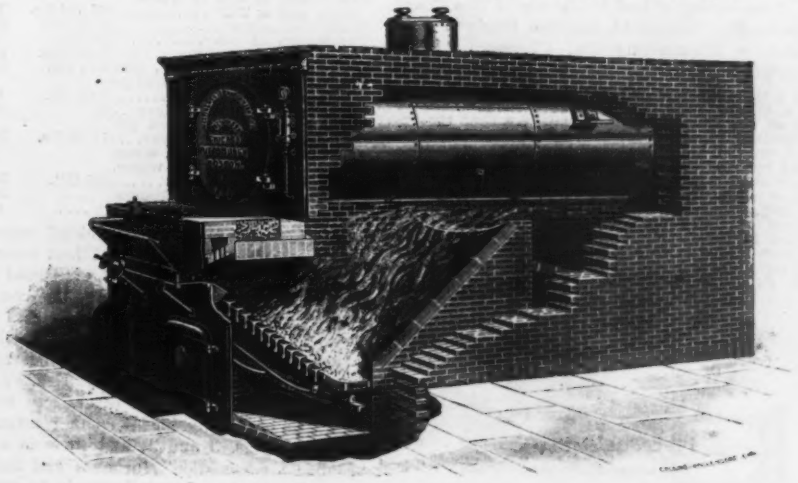


FIG. 4. RONEY MECHANICAL STOKER; Westinghouse, Church, Kerr & Co.

Each bar rests in a concave seat in the bearer and is capable of a rocking motion through an adjustable angle. All the grate bars are coupled together by a rocker bar, the notches of which engage with a lug on the lower rib of each grate bar, pin connections being made with two of the grate bars only for the purpose of holding the rocker bar in position. A variable back-and-forth motion being given to the rocker bar through a connecting rod, the grate bars necessarily rock in unison, alternately forming a series of steps and approximating to an inclined plane.

The mechanism for producing the necessary motions is actuated by a driving shaft. In a single stoker this shaft is driven by a small engine attached to the stoker front, but in a battery of boilers the shaft extends across the front of all and is operated by a small independent engine. The amplitude of motion of the rocker bar is adjustable, so that the amount of fuel delivered and stirring of the fire are regulated by the demand for steam.

The following table shows the results of six tests made for the purpose of ascertaining the comparative capacity and economy of horizontal return tubular boilers when fired by hand and by the Roney stoker. The conditions were, as far as possible, identical in all six tests, except that the first two extended over two weeks, while the remaining four were one week in duration each, and also that four boilers were used on the first test, three on the second and one each for the four succeeding tests. In each test the boilers were banked each night, except Saturday. The record shows the total consumption of coal and water for the entire time in each case. Coal and water were weighed, and temperature of feed and steam pressure recorded each hour:

Duration of test. hrs.	Temperature of feed water, degrees F.	Steam pressure, lbs.	Water evap. per lb. dry coal, actual, lbs.	Water evaporated per lb. dry coal from and at 212°, lbs.	HP. developed above rating of boiler.
		Hand fired.			
123.5	145.7	107.5	9.34	10.36	5.84 "
132.0	143.2	104.6	9.39	10.44	13.52 "
64.25	152.2	66.1	10.02	11.09	68.00 "
		Stoker fired.			
65.5	145.4	63.1	10.81	11.89	54.65 "
64.5	146.0	68.0	11.06	12.25	66.68 "
65.5	145.2	65.2	11.35	12.54	84.26 "

Note.—The same man fired on all six tests.

Jones Under Feed Mechanical Stoker.—The Jones under feed mechanical stoker, manufactured by the Jogada Furnace Co., of Chicago, differs radically from the three stokers previously described. The general appearance of the stoker is shown in Fig. 5. Briefly stated, the stoker consists of a coal magazine, opening into a cylinder, in which a ram operates, as shown in Fig. 6. This ram is operated by steam from the boiler, the direction of the stroke being determined by shifting the hand lever shown. The supply of fuel is thus regulated by the fireman, although the mechanism can be so arranged as to operate automatically if desired. It will be seen that the green fuel is thus pushed up into the burning fuel from underneath. Air, supplied by a positive pressure blower, is forced through the tuyere pipes, passing over the top of the green fuel and thence up through the burning fuel. The result is that the gases, which are slowly liberated from the green fuel by the heat of the burning fuel above, is mixed with the necessary air for combustion and is thoroughly consumed as it passes up through the incandescent mass above. The clinker is forced up and to one side into the side grates by the incoming fuel, and is removed without disturbing the fire in the center of the furnace. To secure the best results, a large charge of coke should at all times be carried in the furnace, but the green fuel should be admitted only in small quantities at regular intervals. The amount of coal consumed is, of course, regulated by the amount of air admitted, so that

when little steam is needed the quantity must be reduced.

Efficiency.—A saving of from 10% to 30% in fuel is claimed for this stoker, depending upon the conditions. Tests made with horizontal tubular boilers at the plant of Fraser & Chalmers, of Chicago, by the Robert W. Hunt Co., to determine the comparative economy of mechanical and hand stoking, gave the following results:

	Jones stoker.	Hand-firing.
Kind of fuel	Streator coal.	
Cost per ton	$2.35	$2.35
Per cent. ash	5.08	7.7
Actual evap. lbs. water per lb. fuel	7.811	6.223
From and at 212°, water per lb. fuel	8.476	6.739
Actual evap., lbs. water per lb. combust.	8.24	6.755
From and at 212°, lbs. water per lb. combustible	8.941	7.315
Actual evap. lbs. per sq. ft. heating surf.	2.88	2.18
From and at 212°, pr sq. ft. heat'g surf.	3.12	2.28
Actual evap. lbs. per sq. ft. grate	80.14	67.1
From and at 212°, lbs. per sq. ft. grate	86.97	72.6
Cost of evap. 1,000 lbs. water from and at 212°	$0.138	$0.174
Cost of 10-HP. for 10 hours	.476	.601

According to these figures, the percentage of saving by the mechanical over the hand stoking was 20.7%.

FIG. 5. JONES UNDER FEED MECHANICAL STOKER; The Jogada Furnace Co., Chicago, Ill.

Tests made at the boiler plant of the Portland Cable Ry., Portland, Ore., eight miles of cable, showed a saving of 13% in fuel by using the mechanical stoker. With five miles of cable in operation there was an average daily saving of 32½% in coal consumed. The importance of this saving will be at once appreciated when it is remembered that the price of ordinary steam coal on the Pacific coast is from $4 to $6 per ton. Some further evidence of the saving of fuel by the use of this stoker is given by Mr. Norman G. Keenan, Engineer Edison Electric Illuminating Co., Cincinnati, Ohio. Mr. Keenan says:

After a thorough test of this stoker and furnace under one of our "Manning" vertical tubular firebox boilers, at our Elm St. station, will say that the results obtained were favorable as compared with same size and type of boiler fitted with common grate bars and fired by hand in the usual manner. The coal used in either case was Kanawha bituminous slack coal. The gross saving in coal effected by use of furnace was 24.29%, from which was deducted 2.29%, being the equivalent of steam used to actuate blower for air blast and to charge the coal into furnace. The net saving was therefore only 22%, equivalent to 281 tons of coal per annum, which at $1.75 per ton amounts to $491.75. From the aforesaid sum we deduct 6% for interest on investment in furnace and appurtenances, 10% for depreciation and 5% for repairs, in all aggregating $252, leaving a net saving of $239.75 per boiler per annum, or 10.73% on cost of the coal used annually under a similar boiler equipped with common grate bars and fired by hand. By the use of the furnace and stoker, combustion is perfect, thus entirely preventing the formation of smoke.

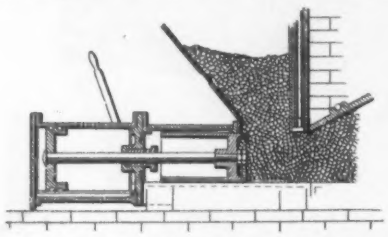


Fig. 6. Section of Jones Uunder-Feed Stoker, Showing Operation of Ram.

It should be noted in this connection that the manufacturers claim the above allowances for deterioration and repairs to be excessive.

Wilkinson Automatic Stoker.—The Wilkinson automatic stoker, illustrated in Fig. 7, is the invention of Mr. A. Wilkinson and was first patented in the United States in 1892. As in the Brightman and Roney stokers, the coal hopper runs transversely across the front of the furnace, and the grate bars incline from its throat to the platform over the ash pit at the rear of the furnace. In the bottom of the hopper is a revolving feed roll for regulating the delivery of the coal to the grate bars. The grate bars are a series of hollow castings of approximately rectangular cross section, and each has a succession of notches or steps cast in the top surface. The upper ends of the bars are open to admit the blast pipes, and in the rise of the steps are small holes, through which the current of air, induced by the blast, is forced to the fire. Each bar is given an independent back-and-forth motion by suitable mechanism. From the hopper the coal is fed to the top of the grate, down which it slowly moves, burning until the ashes and clinkers are deposited on the platform, where they form a seal, as shown by the drawing, preventing the entrance of cold air through the ash pit.

Efficiency.—Tests made by the Eddystone Manufacturing Co. on two horizontal tubular boilers, 72 ins. in diameter and 20 ft. long, for the purpose of comparing hand and mechanical stoking, gave the following results:

	Ordinary grate hand-fired.	Automatic stokers.
Duration of tests	8 hours.	8 hours.
Kind of coal (anthracite)	Buckwheat	Buckwheat
Weight of coal consumed	8.772 lbs.	12.245 lbs.
Weight of water evaporated	59.510 lbs.	96.506 lbs.
Temperature of feed water	109°	140°
Equivalent in lbs. of water from and at 212°	67.622 lbs.	106.156 lbs.
Weight of ashes	1.490 lbs.	2.274 lbs.
Percentage of ash	18.98%	18.57%
Weight of combustible	7,282 lbs.	9,971 lbs.
Weight water evap. pr lb. coal	7.71 lbs.	8.66 lbs.
Weight of water evaporated per lb. combustible	9.03 lbs.	10.64 lbs.
Square feet of grate surface	64	40
Weight of coal consumed per sq. ft. of grate, per hour	17.12 lbs.	38.26 lbs.
Duty performed in HP. measured by 34½ lbs. of water, from and at 212°	196 HP.	307 HP.
Increase capacity with stokers	....	36%
Economy due to stokers	....	15.2%

Another test made at Spreckles' sugar refinery on two 250-HP. Babcock & Wilcox boilers showed 9.72 lbs. of water evaporated per pound of coal as an average of three days' trial. The cost of evaporating 2,240 lbs. of water was 16.34 cts., as against 20.8 cts. with patent grates and hand firing.

Other Stokers.—The five stokers described above have all been quite extensively used. In addition to these there are several others less known, two of which, especially ingenious in construction, are shown in Figs. 8 and 9; and there is a legion of "complete combustion" furnaces and smoke "consumers" and "preventors," which do not properly come in this article.

Fig. 8 shows the general construction of the Pratt automatic stoker, patented in 1890 by Mr. N. M. Pratt, of Brooklyn, N. Y. This is a chain-grate stoker, types of which are quite common in England, upon which the fuel is so placed as to form a seal to exclude the access of cold air through the interstices at the side of the moving grate. The coal is fed into the hopper, which is provided with a roller at the bottom for crushing the larger pieces, and thence falls onto the grate, which slowly carries it, burning, to the rear of the furnace, where the ashes are dropped. As will be noticed, the chain grate is mounted on a truck and can be removed from the furnace for repairs or inspection.

The Hopcraft stoker, shown in Fig. 9, is the invention of Mr. Lewis Hopcraft, of London, England, and was patented in the United States in 1891. The grate is circular, the grate bars being arranged in concentric circles and carried on radial arms, having a sinuous upper surface, and can be revolved by means of the chain attachment shown. Coal is conveyed to the center of the grate by the screw conveyor shown. The other general features of the construction are shown by the drawing. Both this and the Pratt stoker are open to the objection of too complicated construction and operation.

Economy of Mechanical Stoking.—If properly operated there is every reason to believe that a plant of steam boilers mechanically fired will operate with a sufficient economy of fuel over hand-fired boilers to pay a good return on the increased investment required for the mechanical stoking apparatus. Economical combustion for steam boilers consists in the complete consumption of the combustible elements existing in the coal and the transfer of the heat evolved with as little loss as possible to the water in the boiler, without entailing an expense greater than the value of the increased useful heat obtained over incomplete combustion. The conditions necessary for complete combustion are: (1) A sufficient quantity of air, (2) the thorough mixture of the air with the gases of combustion, (3) a high temperature—over 1,000°—of the mingled air and gases.

The mechanical stoker attempts to secure these requisites of complete combustion by a proper regulation of the supplies of air and fuel. Just how perfectly they are secured depends, of course, upon the construction and operation of the particular stoker in use, but with the most expert hand stoking and ordinary grates it is practically impossible to secure complete combustion at all. The loss depends upon the skill and carefulness with which the stoking is done, but in ordinary practice it probably runs from 20% to 30% of the efficiency of the fuel, and to this must be added the hastened deterioration of the boiler due to expansion and contraction by the irregular temperature. On account of the regular temperature obtained, a good mechanical stoker not only lengthens the life of the boiler, but it effects an economy in fuel and labor, and reduces the amount of smoke.

Economy in fuel is due both to the fact that a grade of coal can be used which cannot be used with ordinary grates and hand stoking and keep the steam up, and to the fact that the combustible

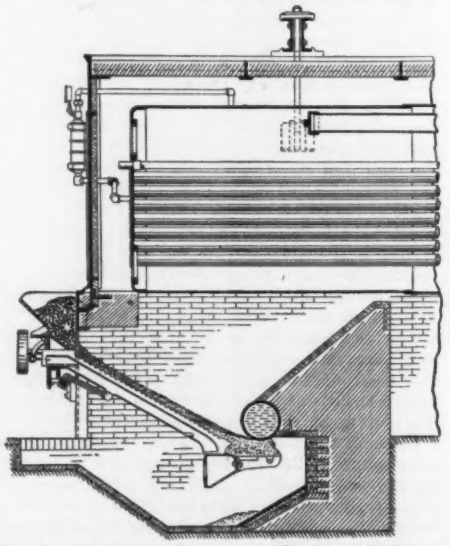
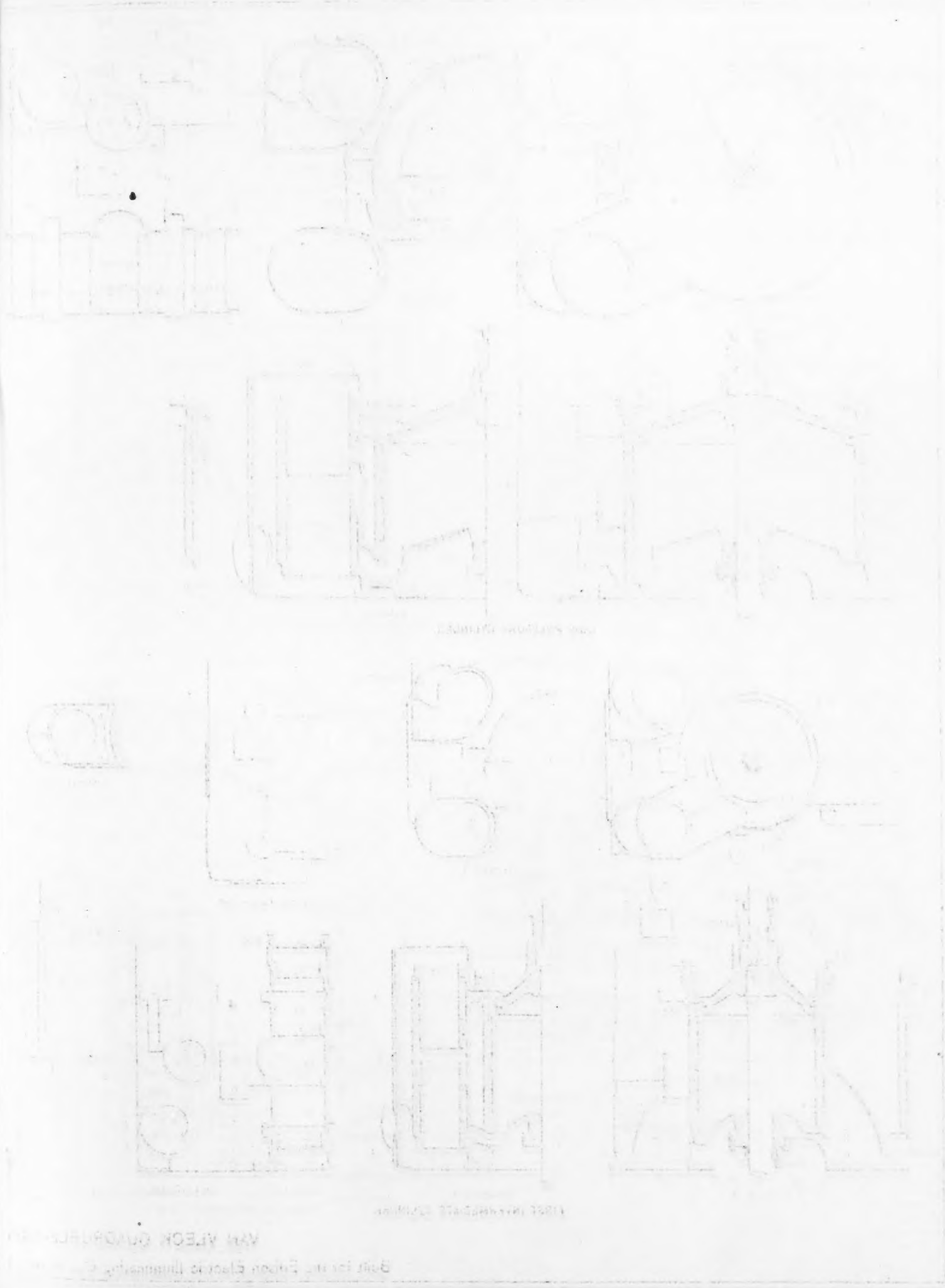
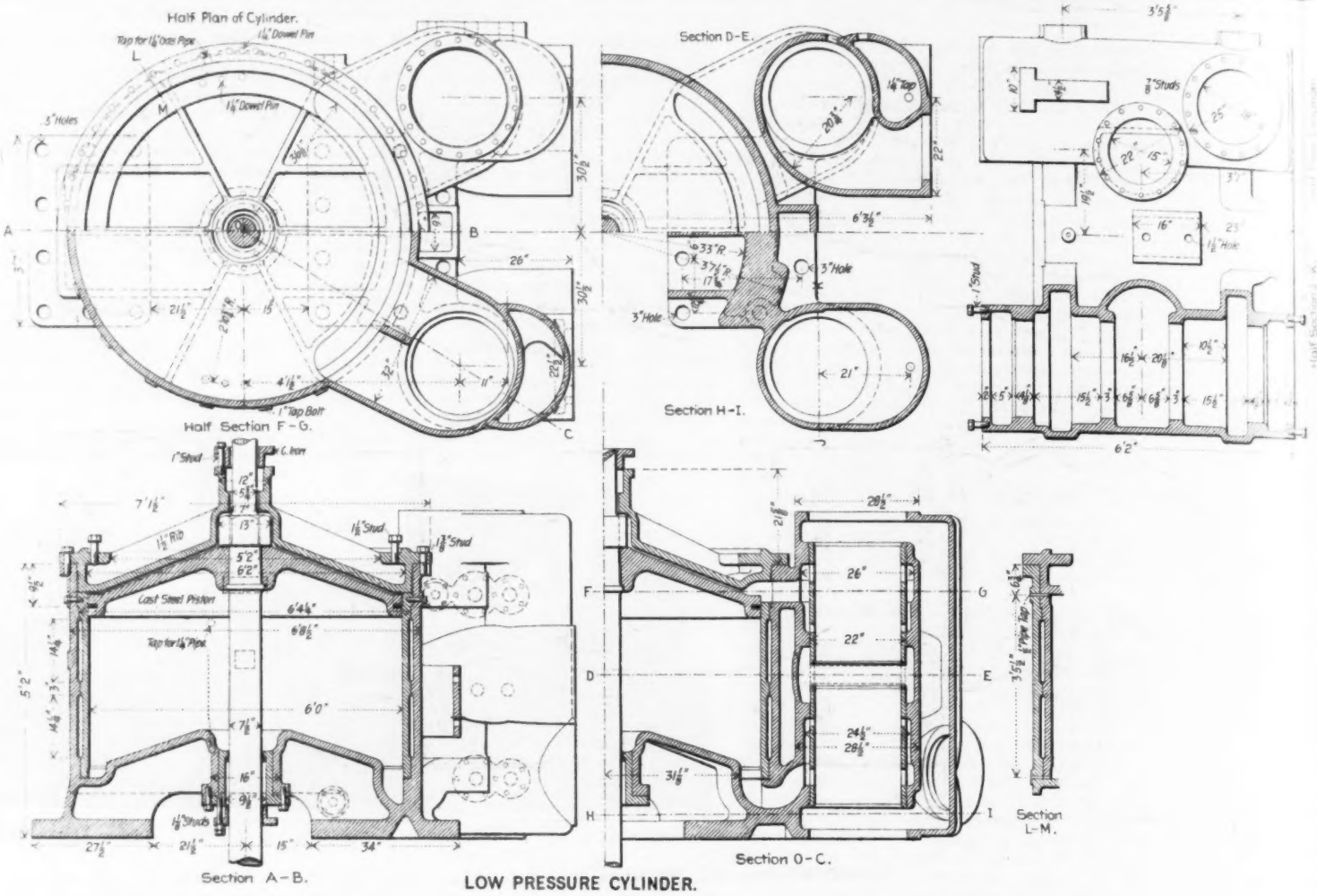


Fig. 7. Wilkinson Mechanical Stoker; Wilkinson Mfg. Co., Bridgeport, Pa.

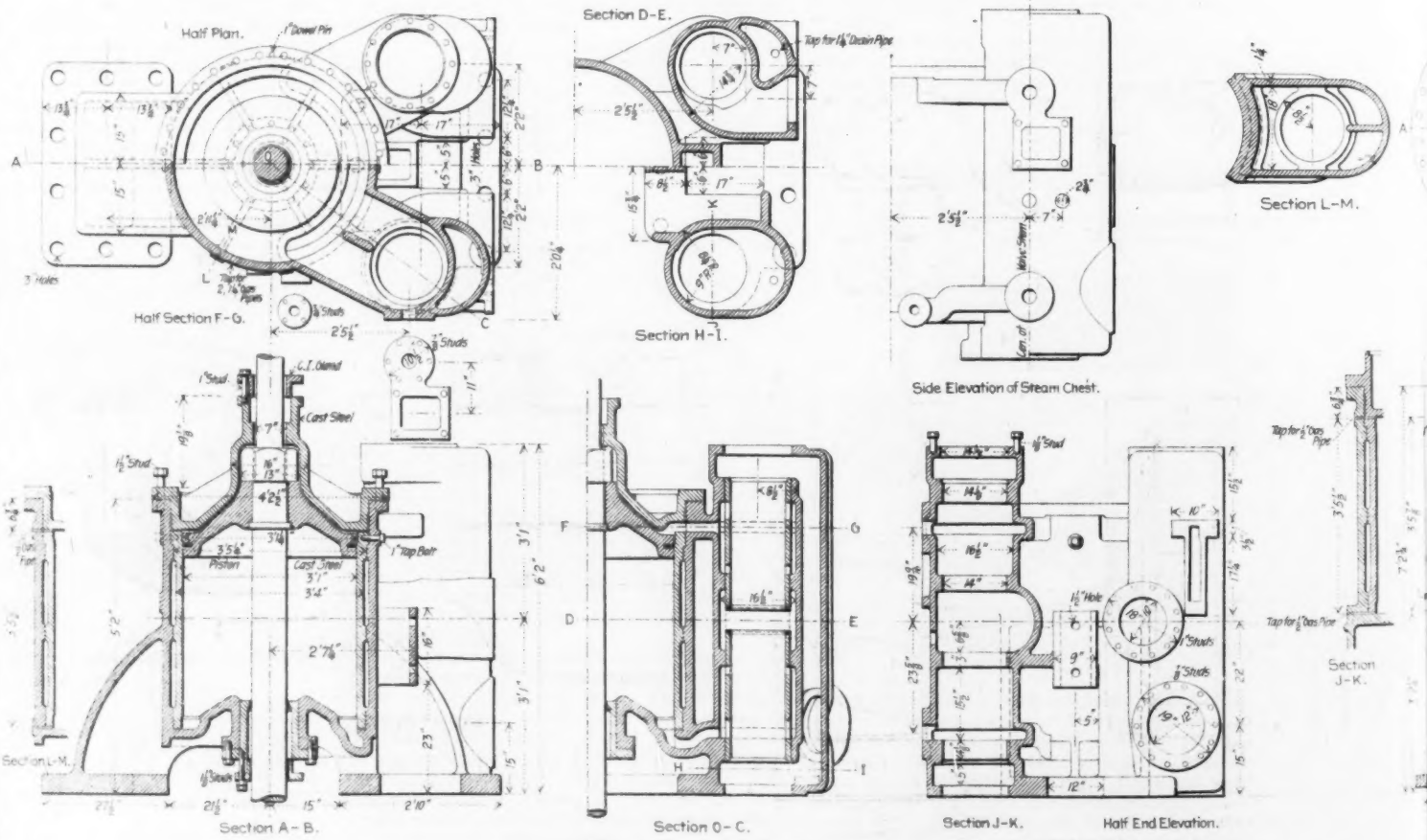
matter of the fuel is more completely utilized. The gain in economy with a rich bituminous coal is owing to this through combustion, greater, perhaps, in proportion to its cost than with cheap Western slack and bituminous screenings. Using the ordinary grades of Western coals, however, experience shows that a gain of from 10% to 30% in economy, depending upon the conditions, can be depended upon over grate bars and hand stoking.

The saving in labor depends upon the number and arrangement of the boilers, and is best shown when coal and ash handling machinery is used in





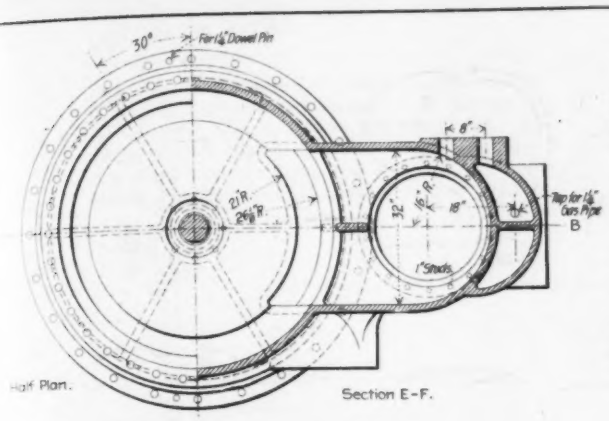
LOW PRESSURE CYLINDER.



FIRST INTERMEDIATE CYLINDER.

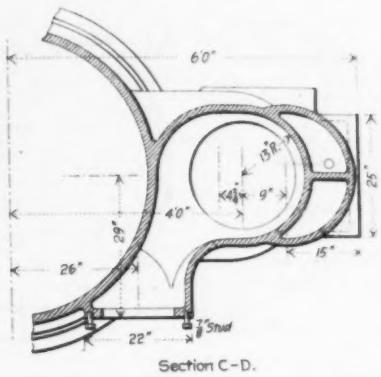
VAN VLECK QUADRUPLE-EXPA

Built for the Edison Electric Illuminating Co., of New Yo

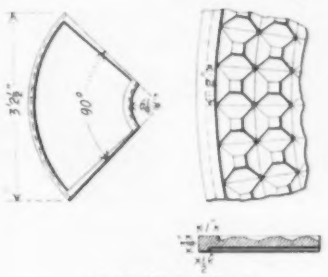


Half Plan.

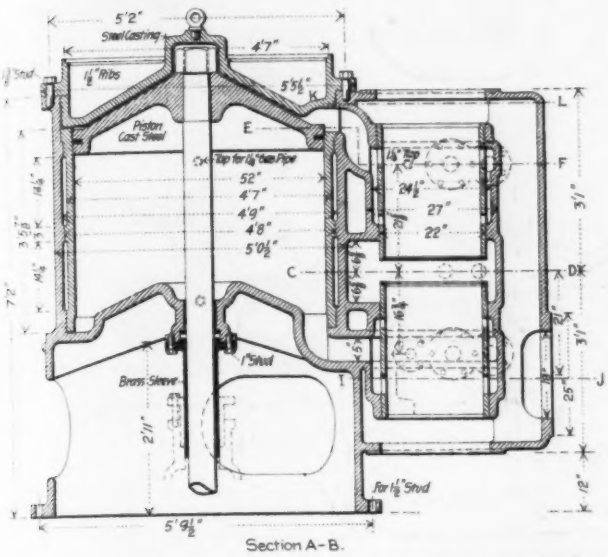
Section E-F.



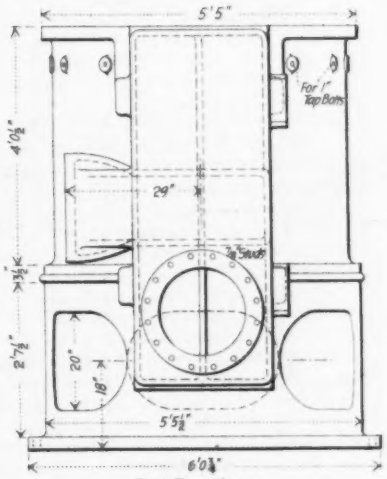
Section C-D.



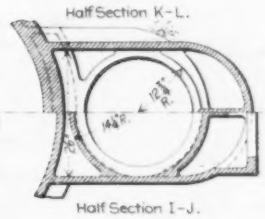
Details of Covering Plates for Cylinder Head.



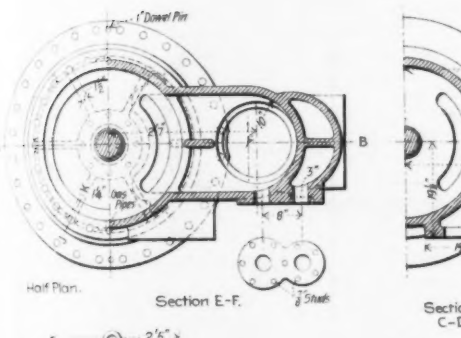
Section A-B.



End Elevation.

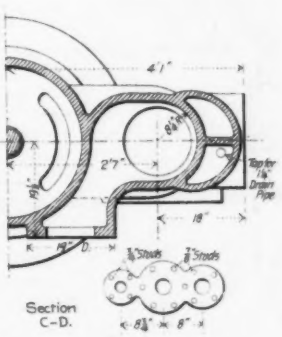


SECOND INTERMEDIATE CYLINDER.



Half Plan.

Section E-F.



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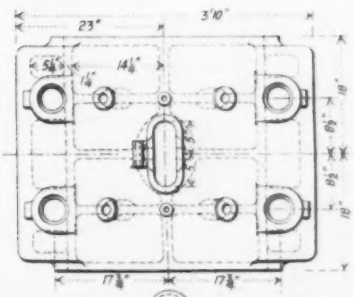
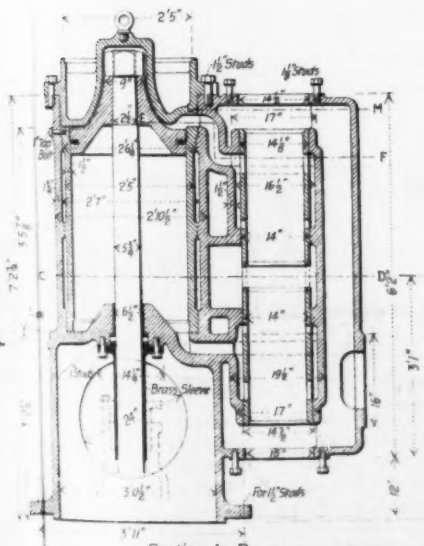
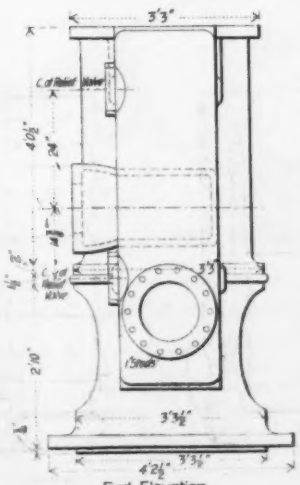
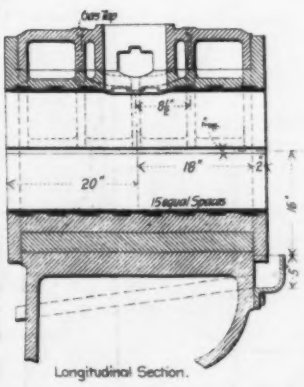




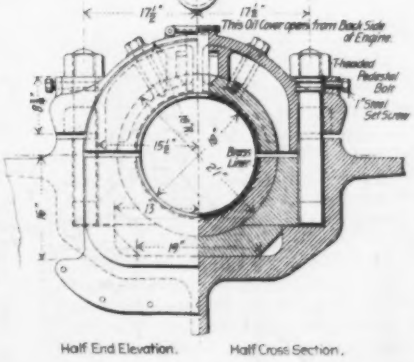
Section A-B.



End Elevation.



Longitudinal Section.



Half End Elevation. Half Cross Section.

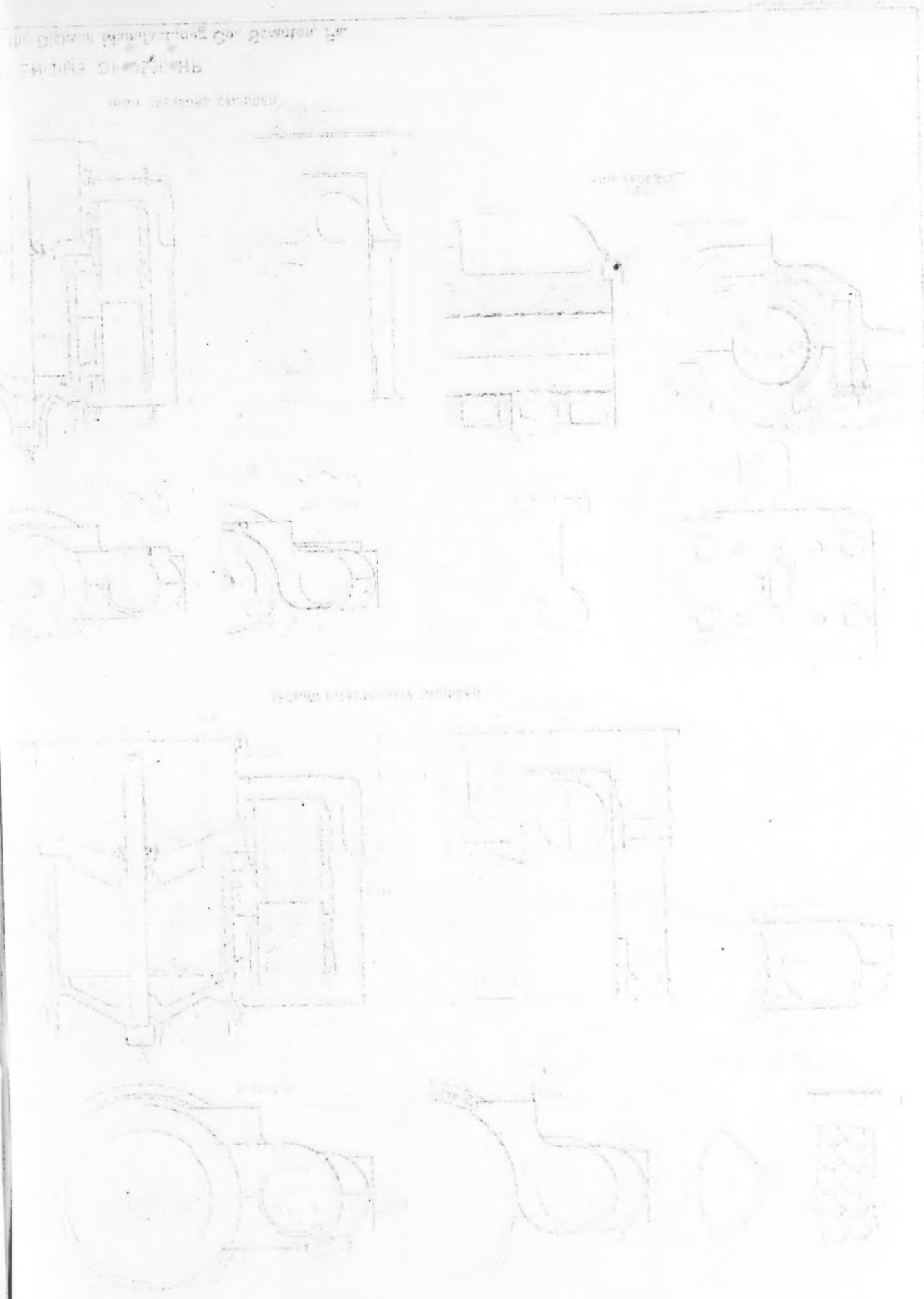
END PEDESTAL.

HIGH PRESSURE CYLINDER.

LE-EXPANSION ENGINE OF 2500 HP.

of New York, by the Dickson Manufacturing Co., Scranton, Pa.

CHAS. HART & SONS, LITH., 26 VESEY ST., N. Y.



connection with the stoker. Ordinarily the number of men in the fireroom is reduced from one-half to three-fourths. At the Claus Spreckels' sugar refinery, in Philadelphia, four men on each shift take the entire care of a battery of Babcock & Wilcox boilers equipped with Roney mechanical stokers,

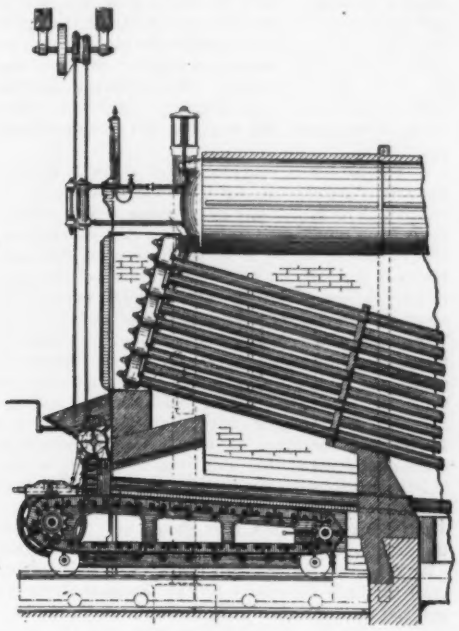


Fig 8. The Pratt Mechanical Stoker.

which regularly develop 8,000 HP. One man is sufficient to remove the ash produced during the entire 24 hours. It is stated that the stoking is done by these four men with less effort that 16 men would exert in firing a similar battery by hand. This plant is showing an average evaporation from and at 212° F. of 11 lbs. of water per lb. of Pocahontas semi-bituminous coal.

It is difficult to say just how much gain in the increased life of the boiler is obtained by mechanical stoking. There is no doubt that it is considerable, however. Expansion and contraction of the plates is one of the most important deteriorating influences in the life of steam boilers, and this is impossible to avoid in hand stoking. In the article before referred to, Mr. William R. Roney says in this connection:

> In hand firing, the coal being charged every quarter of an hour, heat is absorbed in the process of converting the solid fuel into gas. As a result the temperature in the furnace falls about 1,500°, while, as a requisite supply of air cannot be had at a temperature of 1,000°, or in small streams, the gas is only partially utilized until after five or ten minutes, when the temperature rises to its highest point, and then gradually falls until the fire is raked or the firing repeated. These operations, involving variations of temperature exceeding 1,500° with consequent expansion and contraction of boiler plates, not only result in a loss of economy, but prevent the boiler from living out half its days. A good boiler properly set and used in a rational way ought to work at 100 lbs. for 15 to 20 years as a minimum. The great number of boilers that reach the scrap heap long before this time, not to mention those that go skyward by those "mysterious explosions," all emphasize the moral that average hand firing is wasteful of fuel and destructive to boilers.

In addition to this, the increased regularity of temperature which mechanical stoking gives enables high pressure to be carried more safely and prevents the fluctuating pressure so detrimental to engine economy.

In the use and operation of mechanical stokers it is, however, necessary to bear in mind their limitations. With too small boiler power, deficient draft, poor coal, and careless attendance, they will not give good results any more than hand firing will. With fair conditions and intelligent management they will give good results, and the better the conditions the better will be the results.

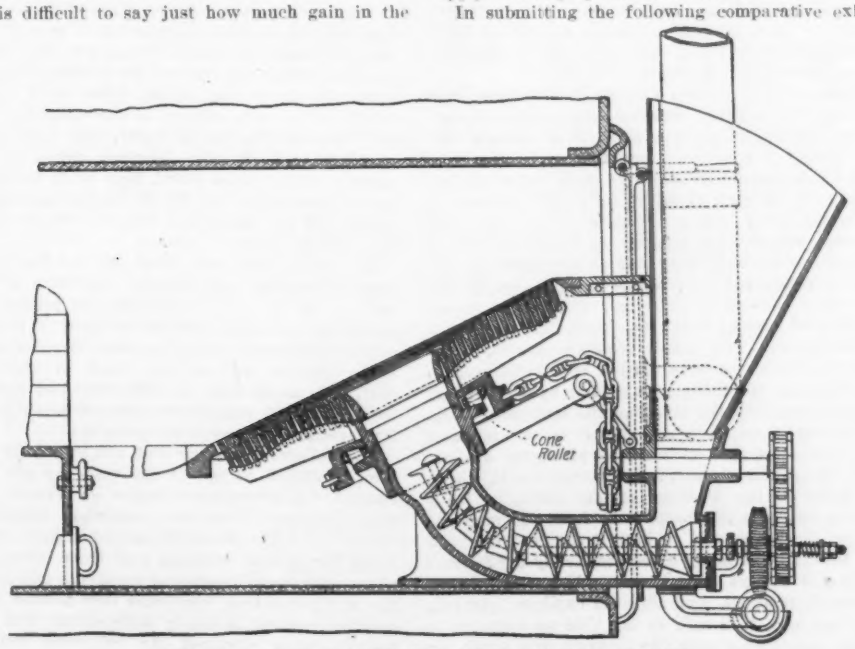


FIG. 9. THE HOPCRAFT MECHANICAL STOKER.

ROUTES FOR THE MARYLAND-DELAWARE SHIP CANAL.

In a late letter to the Trades League of Philadelphia, Mr. L. M. Haupt, Consulting Engineer to that body, discusses the relative economies of the various canal routes proposed for furnishing a shorter outlet from Baltimore to the sea, across the Maryland-Delaware peninsula. Mr. Haupt first points out the fallacy of the "straight-line-to-the-sea" plan so often and so strongly urged by well-meaning advocates of similar enterprises. These advocates forget that the speed in a comparatively narrow canal is limited to five miles per hour, and that in the case of the proposed canal across New Jersey, from Philadelphia to the sea at Atlantic City, a vessel could steam between these points via Delaware Bay and the sea in less time than she could pass between the two points through the canal. Then, too, about 75% of the commerce is coastwise, with a path practically at right angles to the air-line to the sea. These points especially apply to the proposed Baltimore canals.

In submitting the following comparative exhibit Mr. Haupt uses as a unit of measure the cost of saving one mile of distance, or one minute of time, in transit. It is also useful to remember in this connection that the cube of the Manchester canal was 46,000,000 cu. yds., and the total excavation for the removal of the islands in the harbor of Philadelphia, now under contract, is 21,500,000 cu. yds. The prices used in the revised estimates of Captain (now Major) Turtle were fixed in 1883, and the improvement in dredging appliances within the last ten years would materially reduce the cost.

The following table is compiled and computed by Mr. Haupt, and he introduces it with the note that: The time to Cape Hatteras from Baltimore, via Cape Charles, is 33 h. 15 m. The distance is 325 miles to a point 12 miles outside the Delaware capes:

TABLE I.—Physical Features.

Name of route.	Total length, miles.	Length of canal, miles.	Dredging and excavation, cu. yds.
1. Choptank	149.81	37.67	12,000,000 74,452,621
2. Wye	128.42	42.90	9,000,000 119,772,787
3. Queenstown	107.29	53.78	4,100,000 176,871,088
4. Centreville	106.38	50.95	11,940,000 190,300,000
5. Southeast Creek.	115.78	38.35	10,340,000 112,800,000
6. Sassafras	129.25	16.20	9,800,000 23,773,000

The above estimates are for a canal 26 ft. deep, 100 ft. wide at bottom, 178 ft. at top, berme 12 ft., slopes 1½ to 1, locks 60 × 600 ft., draft 23 ft.

The revised estimates of Capt. Thomas Turtle, U. S. E., March 1, 1883, call for a canal 27 ft. deep and 100 ft. wide at bottom, with the following results:

7. Choptank	149.81	37.67	20,083,082 80,600,800
8. Sassafras	129.25	16.20	26,988,941 35,988,723
9. Back Creek, Ches. & Del. Canal.....	136.00	13.62	29,542,386 22,021,490

Note.—In both of these estimates, under the head of quantity, the first line indicates the amount of dredging required and the following line indicates the amount of excavation proper for the route in question.

TABLE II.—Economic Factors.

Route.	Cost.	Time in transit.	Time saved.	Distance saved, miles.	Cost, per mile.	Cost per mile of distance saved.	Cost per minute of time saved.
	$	h. m.	h. m.		$	$	$
1.	16,413,312	19:30	13:45	175	109,560	93,790	19,895
2.	26,554,493	17:45	15:30	196½	206,700	133,842	28,553
3.	37,261,235	17:00	16:15	217¾	347,294	170,871	38,217
4.	41,558,000	16:30	16:45	219	390,656	189,497	41,357
5.	24,825,330	15:45	17:30	209¼	214,419	119,617	23,643
6.	8,085,330	15:10	18:05	195¾	62,555	41,305	7,445
7.	18,184,766	19:30	13:45	175	121,380	103,913	22,042
8.	11,409,909	15:10	18:05	195¾	88,278	58,214	10,546
9.	7,605,471	15:35	17:40	189	55,922	40,240	7,175

In answer to the question of whether such a canal would pay or not, Mr. Haupt says that the present commerce of the two bays, Delaware and Chesapeake, aggregates over 30,000,000 tons per annum. If but one-third of this used the canal it would represent a saving of 1,890,000,000 ton-miles, which, at 2 mills, or one-half the lowest rail rate, would mean $3,780,000 per annum saved on transportation over this route. This is the interest at 5% on $75,000,000, or nearly fifteen times the probable cost of the Back Creek Canal, estimated at present prices for such work. It is not necessary to point out, says Mr. Haupt, after an examination of the figures presented, that the Back Creek route or the line of the present Chesapeake and Delaware Canal in continuous service since 1829 is the one which best fulfills all the conditions of the problem.

A 2,500-HP. QUADRUPLE-EXPANSION ENGINE.

(With Inset.)

In our issue of Jan. 11, 1894, we presented a description, illustrated by a perspective view and elevation, of the 2,500-HP. quadruple-expansion engine recently installed in the Duane St. station of the Edison Electric Illuminating Co., of New York city, and built by the Dickson Manufacturing Co., of Scranton, Pa.

We show on our inset sheet this week detailed working drawings of each of the four cylinders of the engine and one of the end pedestals. As seen by the drawings, the engine is similar to a standard vertical inverted marine engine in its general design. The pistons and the cylinder covers are steel castings, and the engine is a fine specimen of good workmanship throughout. Credit for the design of the details of the engine is due to Mr. John Van Vleck, Chief Electrician of the Edison Electric Illuminating Co., and Mr. J. W. Sargent, late Consulting Engineer of the Dickson Manufacturing Co., and now connected with the Rice & Sargent Engine Co., of Providence, R. I. The special features of the engine were described in our former article referred to above. We believe we are correct in stating this engine to be the most powerful vertical stationary engine thus far constructed.

BIDS FOR MUNICIPAL ELECTRIC LIGHTING PLANT FOR KALAMAZOO, MICH.

On July 12 the city of Kalamazoo, Mich., received bids for constructing an electric lighting plant for street service, accompanied by estimates of the operating expenses of the system. The specifications required that each bidder for the electrical plant should guarantee that the operating expenses for five years should not exceed a certain sum, under a bond of $15,000, and that the company securing the contract should forfeit any excess over its guarantee during the period named.

The bids for engines were on the basis of 200-HP. engines, rated at 90 lbs. steam pressure, as follows:

Arbuckle, Ryne & Co., on Russell four-valve, compound, condensing, with extension shaft and clutch pulleys, belted direct to dynamos, with two 125-HP. Stirling boilers	$10,888
*H. P. Allis & Co., engines and jack shafting	8,555
*Hamilton Engine Co., engine only	5,750
*Nordberg Mfg. Co., engine only, for a cross-compound	5,500
*Nordberg Mfg. Co., engine only, tandem compound	5,750
Watertown Steam Engine Co., engine only	5,450
New York Safety Steam Power Co., engines and boilers	10,450
Buckeye Engine Co., engine and line shafting	7,000
Ball Engine Co., engine and shafting	5,979

*Corliss engines.

Bids for two 125-HP. boilers, "rated under the standard Philadelphia schedule," set complete, including stack, were received as follows:

Heine Boiler Co.	$6,730
Babcock & Wilcox Boiler Co.	6,343
Abendroth & Root Boiler Co.	5,125
Wicks Bros., Wood Boiler	4,698
Arbuckle, Ryne & Co., Stirling boiler	4,918
Campbell & Zell Boiler Co.	6,550

The bids for electrical equipment, including three 80-light 2,000-c. p. dynamos, with circuit complete having 170 lamps ready for lighting, were as follows:

Fort Wayne Electric Corporation	$25,860
Commercial Engineering Co., standard system.	22,044
Western Electric Co.	21,000
Brush Electric Co.	26,325

The guarantees submitted under bond for operating expenses were as follows:

Ft. Wayne Electric Corporation, 170 lights burning all night 275 nights per year	$7,820
Commercial Electric Engineering Co., 130 lights burning till midnight 260 nights, and 40 lights burning all night 300 nights per year	7,333
Same company, 170 lights burning all night 275 nights per year	8,255
Western Electric Co., 130 lights burning till midnight 260 nights per year, and 40 lights burning all night 300 nights per year	8,160
Same company, 170 lights burning all night 275 nights per year	10,636
Brush Electric Co., 170 lamps burning all night 275 nights per year	12,750

As an informal bid, the Kalamazoo Electric Co., which now lights the streets, offered to enter into a five-year contract for 170 lights burning all night 275 nights in the year for 36 cts. per lamp per night, or a total of $16,830.

In addition to the offer just cited the local company made additional proposals as follows: 40 lights burning all night 300 or more nights per annum for 40 cts. each per night, which would be $4,800 per year for 300 nights; 130 lights to midnight at 25 cts. per light, or $8,937 per year; making for the 170 lights $13,737 per year. For lamps burned every night in the year the local company made no reduction in its price per lamp per night, a point against its offer as compared with a municipal plant, since the interest and bond redemption account for the latter would be the same if the lights were burned every night and some of the other expenses would not increase in direct proportion to the time the plant was operated.

Mr. Edson D. Clarage, the electrical expert for the city, informs us that the city is not bound to select the lowest bid for furnishing apparatus, and will probably award the contract to the concern offering the best guarantee. This was the Ft. Wayne Electric Co., whose guarantee was $7,820 for 170 lights burning all night 275 nights in the year, and whose bid for electrical equipment was $25,860.

From a communication sent us by Mr. Clarage we infer that one of the bids for a combined engine and boiler plant will be accepted. The lowest of the two bids for the combination was $10,450, from the New York Safety Steam Power Co. This sum, added to the $25,860 for the electrical equipment, would make the total cost of the plant $36,310. Making a liberal allowance for buildings, engineering and superintendence, the total cost of the plant may be assumed as $50,000. At 5%, the interest charges on this sum would be $2,500 per year. Assuming that 20-year bonds were issued, the annual contribution to the sinking fund would be, assuming this fund to earn only 4%, about $1,675.*

We then have $7,820 for operating expenses, $2,500 for interest and $1,675 for sinking fund, making a total of about $12,000 as the yearly cost of light from a municipal plant, against $16,830 for the service offered by the local company.

Mr. Edson D. Clarage drew the specifications upon which the above bids were based, and we are indebted to him and the city clerk of Kalamazoo, Mr. Chauncey Strong, for the information given. Mr. H. C. Potter is secretary of the Kalamazoo Electric Light Co.

AN IMPROVEMENT IN PNEUMATIC CAISSONS.

By W. M. Patton, C. E.

It is not intended in this article to explain or discuss the detailed construction of caissons or methods of sinking them. The following discussion and description will be confined to a method of improving the character of the resulting structure in all cases and of providing a safe, rapid and economical means of sinking caissons and cylinders to a depth greater than that recognized as the limiting depth attainable by the pneumatic process proper.

The basis of this discussion is that (1) it is desirable to avoid the use of a timber or iron partition or roof separating the mass of concrete in the working chamber of the caisson and the concrete or masonry above, because such a partition destroys the homogeneity and monolithic character of the foundation or structure. However perfectly the filling with concrete of the working chamber may be done, it often, if not commonly, happens that an inferior grade of concrete or masonry is built over the roof of the caisson owing to the almost unavoidable presence of water and the consequent washing out of the cement in the fresh mortar. Moreover, whatever design of crib may be built above the caisson for holding the concrete, the necessary existence of a number of braces materially interferes with the work of concreting, and in some designs must result in defective work.

Where a timber roof, varying in thickness from 4 to 20 ft., or more, separates the column of concrete into two distinct portions, it is claimed that the timber has ample strength to carry the load, and being constantly saturated with water its durability is insured. Timber fully and constantly saturated with water becomes soft, soppy and spongy, whereby its capacity to resist crushing is greatly reduced. It may not be too much to say that if submerged foundations or platforms of timber were constantly saturated, they would be incapable of bearing safely the loads that have been superimposed. The timber would compress, under such conditions as to saturation and loads, even to the extent of producing such settling as would crack or even endanger the safety of the structure. That these conditions have not arisen is an argument going to show that such timber platforms are not as a rule constantly and fully saturated with water. In addition, the tendency of the enormous loads resting on these platforms is to force the moisture out of the timber and to keep it out, and may not the timber be in many cases practically dry? Such timber is always built in when but very slightly seasoned, if at all, and with the caulking, planing, grouting, etc., it is safe to say that such timber is rarely saturated during the framing and never becomes so afterwards. Therefore the conditions for ultimate decay are all favorable. That the process will be slow is admitted, but it will be none the less sure.** The writer believes that the settling and cracking of many structures which is attributed to the yielding of the foundation bed, is due in many cases to the squeezing or rotting of the timber, and in some cases he knows it to be so. Few engineers who have built important structures on timber platforms, I think, have done so without some misgivings and doubts.

There does not seem to be as many or as serious objections to the use of an iron partition, or roof, as this is usually built of beams and thin plates, and even assuming the ultimate decay of the material but little settlement could take place from this cause. The other objections may or may not exist in an all-iron caisson. On general principles, however, it would be certainly desirable, other things being equal, not to divide the column of concrete at all.

2. The laying of concrete under water is unquestionably objectionable, by whatever means it is deposited. The writer has never come across a statement from any source to the effect that concrete deposited under water is as good as when laid and rammed dry. From the very nature of the case there are comparatively few reports ever made upon the quality of concreting done under water. The inside of a crib or caisson cannot be examined when once filled, and no living soul can know its condition. When an examination is made, the reports are to a great extent indefinite and unsatisfactory. A statement that the concrete is in a fairly good condition on the surface examined is occasionally made; but as a rule the report is that it is positively bad, but little, if any, better than so much broken stone and sand. Surely if such conditions can be avoided, they should be. Why go to the expense of using cement, if it is simply wasted?

3. When a greater depth below the water surface than the limit attainable by the pneumatic process, say 100 ft., is required, the common rule is to abandon entirely the pneumatic caisson and the pneumatic process, and to resort to the open crib design and the method of sinking by means of some form of dredging apparatus working through shafts or tubes. Admittedly this is an uncertain, risky and unsatisfactory method, and is adopted solely because there is nothing else to do. The difficulties and objections are many: (1) The difficulty of sinking against an unknown and enormous frictional resistance on the exposed outer surface of the crib; (2) the risk of encountering logs, old wrecks, etc., or even a stratum of compact clay or hardpan, which can only be reached or removed or penetrated by slow and expensive work with divers, who can only work in depths and for periods determined by their power of endurance; (3) the filling with concrete, which is the main support of the structure, has to be done entirely under water, the objections to which have been fully discussed above—such columns of concrete, so called, may be in height anywhere from 100 to 200 ft; (4) the leveling and preparation of the foundation bed, as well as the entire sinking are left to chance.

The writer does not think that he has made a single statement not entirely consistent with the facts or in any way overdrawn the picture as regards the conditions existing in many if not in all of our foundations under important structures. The facts admitted, any method which, in whole or in part, does away with the difficulties and objections to the old and commonly employed methods is at least worthy of careful consideration.

The following designs and methods have never been published, except in the work by the writer entitled "A Practical Treatise on Foundations." The drawings there are somewhat complicated, as several different conditions and designs are provided for in one drawing, and from recent interviews with some prominent engineers and builders the writer has been convinced that neither the design nor method is clearly understood. The writer has therefore prepared the following drawings, Figs. 1, 2, 3 and 4, to which the following description refers.

The first view considered will refer to the design as a substitute for the ordinary pneumatic caisson for depths below the water surface not exceeding 100 ft. In Fig. 1 is shown a half vertical section of the structure, and in Fig. 3 a full horizontal section taken along any of the lines A B in Figs. 1 and 2. It will be noted that the general design is the same as that commonly used in the open crib and dredging method. The drawing shows a timber structure; the general design would be the same if iron should be used instead of timber. In either case the weight required to cause the sinking is

*See "Tables for Calculating Sinking Funds and Present Values," Eng. News, Jan. 25, 1894.

**Mr. Patton appears to argue on the assumption that it is the saturation which keeps submerged timber from decay. If, on the other hand, it be considered that it is the perfect exclusion of air which effects the preservation, it is not apparent that submerged timber would not be preserved equally well, though the water were largely squeezed out by a superimposed load.—Ed.

deposited in the hollow outer and cross walls. But instead of the shafts formed by these outer and cross walls being left open from top to bottom for the purpose of removing the excavated material with the dredger, one or more horizontal partitions, or roofs, are placed between the walls, thus dividing the shafts into one or more chambers, as shown in Fig. 1. The usual main shaft, air lock, supply and discharge pipes are also shown. Thus the open crib design is converted into a pneumatic caisson. Except that the weight of masonry or concrete is not placed on the roof or deck of the caisson, the process of sinking is identical in every respect with that employed in the ordinary pneumatic caisson, whether the depth to be reached is 20 or 100 ft. The remaining portion of the construction is entirely different. Having reached and leveled off the foundation bed, the lower air chamber is partially filled with concrete by the usual method, except that simple layers are placed covering the entire area enclosed, and the slow, expensive and trying work necessary to pack under and against the roof, and working from all sides to close in on the main shaft and leave a final means of crawling into the main shaft, and the subsequent delay and inconvenience in filling this shaft, are entirely avoided. Having filled the air chamber to any convenient height, the air may be entirely withdrawn, and if from any cause, which is not infrequent, water follows the reduction of the air pressure, the pressure can again be raised.

Roof No. 1 being entirely removed, roof No. 2 practicable to reach a greater depth, as under such circumstances no means were provided for doing so, and if this has not occurred it may be liable to occur, as borings cannot always be relied upon to determine either the thickness or character of the strata when at great depths below the surface, the material proving either to be harder and firmer or softer and thinner than indicated by the borings. By the use of the caisson designed as above explained, the engineer is in a condition to continue the sinking to a greater depth, or to introduce piles and drive them to any desired depth into the underlying material. No additional cost has been incurred, the strength and suitableness of the caisson have not been impaired. The entire supporting mass of concrete has been placed without any inflow of water. The upper chambers can be used for the men leaving the caisson, thereby giving comfort and safety to the men, and preventing the otherwise rapid passing from a high degree of air pressure, as these chambers can be filled with air at a pressure proportional to their depth. The passage from chamber to chamber may be through locks placed in the several roofs, increasing the number and means of escape, and all without obstructing in any manner the full and continuous work of sinking.

In sinking the caisson for the pivot pier of the Harlem River bridge, the design was to have a monolithic mass of concrete, all laid in the dry, to support the superstructure. Had the method above described been pursued, there is no doubt that success would have crowned the effort, instead of in this chamber, the material is lifted and deposited in troughs, from which it can be carried out through pipes by means of the air pressure or by sand and mud pumps. As weight is added and the material excavated, the caisson sinks, when roof No. 2 comes near the water surface, which is maintained by the air pressure at a constant level. Roof No. 2 is removed, the men ascend above this roof into the new air chamber, the roof of which is No. 3. The excavation is continued, and roof No. 3 comes near the surface, it is removed, and so on. The condition then existing is shown in Fig. No. 2, in which roof No. 4 covers the working chamber. This operation can be continued to any desired depth.

The advantages gained are: (1) We have employed the certain, rapid and economical pneumatic process to its extreme limit, say, 100 ft. (2) The frictional resistance on the outer surface of the structure can be reduced to a minimum by the natural escape of air, if any, under the cutting edge, or, if necessary, by opening valves in small outlet pipes reaching from the air chamber through the side walls to the outer surface, this escaping air rising along the sides of the caisson and loosening the material in contact with it. (3) The probabilities are that any accumulation of logs or wrecks will have been found in the upper 100 ft., where they can be reached and removed by the caisson men, without any special difficulty or cost. (4) Although the filling in with concrete for that portion of the caisson below the 100-ft. limit must be done under

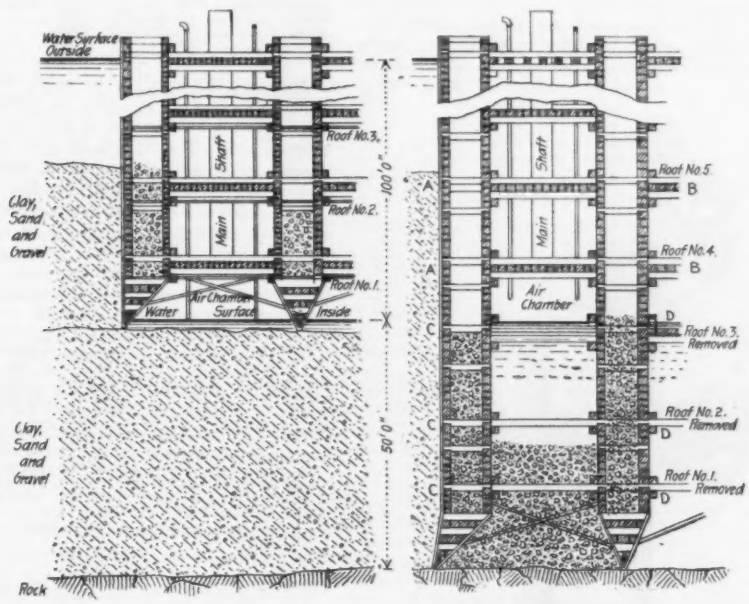


Fig.1. Half Vertical Section of Caisson.

Fig.2. Half Vertical Section of Combined Crib and Caisson.

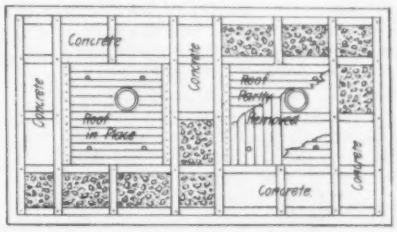


Fig.3. Horizontal Section A-B.

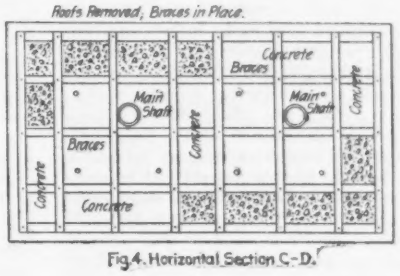


Fig.4. Horizontal Section C-D.

now forms the roof of the new air chamber, the air pressure being reduced according to the depth of the top surface of the concrete in the lower or first chamber, and the concreting is carried on up to, or nearly up to, roof No. 2. If on a reduction of the air pressure water still continues to flow in, roof No. 2 is removed, and the space between the upper surface of the concrete and roof No. 3 becomes the new air chamber, which can be filled under a correspondingly reduced air pressure. If in either case water does not follow the reduction of the air pressure, the entire series of roofs can be removed and the concreting done in the open air. In either case the result is a homogeneous monolith of concrete unbroken from bottom to top. In some soils one roof will be sufficient, but the writer has generally found that the filling of the lower air chamber will seldom be found sufficient to keep out the water under a head of 50 feet or more; but doubtless by the time the second roof is reached, the resistance to rapid inflow of water will be sufficient to admit of the work being done in the open air.

Incidentally many other advantages are secured by the system above described. While it may not be of record, it doubtless has occurred that, having reached the limiting depth of the pneumatic process, it has been decided to build on the material found, simply because it was not considered the failure which actually occurred, making necessary the depositing of the concrete under water.

The above sets forth the advantages of the design shown in Figs. 1 and 3 over the pneumatic caisson proper as usually constructed. In Fig. 3 the roof in one division is shown complete and in the other as partly removed. However desirable this method may be for depths under 100 ft., its application to depths greater than 100 ft. will prove relatively more advantageous than the usual method adopted. It is this view of the subject that will now be discussed. In Fig. 2 is shown a half vertical section of the same structure sunk to a considerable depth over 100 ft. below the water surface. The sinking to the limiting depth of 100 ft. by the pneumatic process is the same as already described, and it shows roof No. 3 as having reached to that depth, roofs Nos. 1, 2 and 3 being removed, only leaving in place a few pieces which serve as braces. This condition is shown in Fig. 4, which is a horizontal section taken along any of the lines C D in Fig. 2.

Assuming the caisson as in the position indicated in Fig. 1. The sinking is continued until roof No. 1 is near the 100-ft. level. This roof is then removed as described, the caisson men ascend above this roof, the air chamber now being the space between the water surface and roof No. 2, the dredging is carried on from platforms constructed water, and will be to that extent more or less imperfect, the upper 100 ft. of concrete can be laid in the dry by removing successively roofs Nos. 4, 5, etc., as already described. This long column of good, sound concrete, supported on and by the side and cross walls of the structure, will serve to transmit the load above to these and, in turn, to the material upon which the structure rests, which, together with the frictional resistance, over a large surface, will be ample to carry safely any load likely to come upon it, without regard to the mass of broken stone, gravel, sand or imperfect concrete filling the space below the water surface; and at such a depth either of the above materials could be used with perfect safety, as has been exemplified in more than one important structure where a sand filling has been employed. (5) The lift of the dredged material is reduced to a minimum. In the ordinary open crib process, the average lift of the material (as each bucketful has to be lifted to the top and above the structure) in the case shown would be about $\frac{175}{2} = 87\frac{1}{2}$ ft., whereas by the method described the lift would be only $\frac{50}{2} = 25$ ft.

The method described involves no complications in construction, no increased cost for material or

workmanship and no sacrifice of convenience or strength. On the other hand, many decided advantages, in the character of the resulting sub-structure and in the convenience, comfort and safety of the workmen have been provided, and all difficulties in and objections to the ordinary methods have been wholly removed or reduced to a minimum.

The writer invites criticisms and will be only too glad to have any defects in the design or method of sinking pointed out, as well as any error or fallacy in the argument he has made for the improved method of construction.

ACCIDENT ON THE BROOKLYN BRIDGE CABLE RAILWAY.

A singular derailment accident occurred on the Brooklyn Bridge cable railway on the afternoon of Saturday, Aug. 4, and might have had serious results in personal injuries but for a fortunate combination of circumstances. A New York train of four cars was being pushed out from the Brooklyn station by a locomotive to the point where the cars pick up the cable. On the sharp curve just at the end of the station the rear truck of the rear car jumped the track, the inner wheels struck the end of the guard timber, and a few feet further on the wheels mounted both guard rails, ran along a little distance on the ends of the ties, with the end of the car body slewing over until it fell sideways off the structure onto the side of the roadway and thence into the middle of the roadway. By this time the drawbar pulled out and the car came to rest, lying on its side with the rear end in the road and the front end resting by the sill and platform on the track above. The car fell or slid slowly into this position, carrying away the cabin occupied by the man who looks after the picking-up apparatus and also the covering over a stairway. There were few passengers in the car, and neither they nor the two brakemen, nor the pick-up attendant, were injured beyond a few scratches and bruises. In tilting over, the car body lifted out the center pins of the trucks. The forward truck kept the track, but the rear one turned a somersault and landed bottom up on the masonry alongside of the roadway.

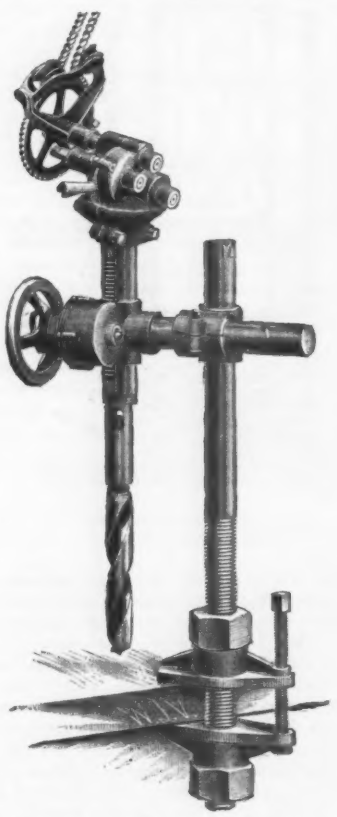
Press reports attributed the derailment to a broken side-bearing falling upon the track, but it appears to be certain that there was no such cause. Personal inquiry and investigation lead us to believe that it was due primarily to three causes: (1) A kink in the outer rail on a sharp curve; (2) a badly worn rail; (3) a stiff truck, with unlubricated center plate. On the sharp curve where the wheels first left the track is a split switch, turning off on the inside of the curve, used by the engine in running into the station after it has "kicked" the train out to the cable. The flange pressure on the outer main rail is very severe, and we are informed that the rail has to be removed every few weeks. The whole track can be seen to shift and work as the trains pass over it. About midway between the heel and point of the switch rail there is a decided kink in the outer main rail, which the wheel flanges must strike very hard, and right here the first derailment seems to have occurred, a groove cut in a rail-brace just beyond being almost in line with the direction of the rail back of the kink. Inspection of the truck showed a very dry and bright center plate, which had evidently not been properly lubricated. The truck would, therefore, be somewhat stiff and would not take the curve easily, so that when the wheel flange struck the kink in the rail it easily mounted the sloping head of that rail. The wheels were not sharp flanged, but in good running condition.

On the inner side of the track one wheel appears to have struck the end of the guard timber (which timbers begin just beyond the point of the switch) and passed to one side, while the other wheel passed on the other side, the latter mounting the guard rail a little further on. The car went over so gradually that little serious damage was done, and many of the windows were unbroken. A pile of timber paneling (used to close the engine room skylights in winter) was right under the car, and this broke in one of the door posts and smashed some of the sheathing and window posts. The comparatively slight damage was no doubt due largely to the heavy and substantial construction of the car, the weight of a standard Bridge car, complete, being nearly 20 tons. The trucks had composite frames, and the rear truck appeared to be little the worse for its fall.

The accident happened in about as fortunate a way as could have been possible. The train was moving slowly and there were few passengers. The train ahead had been well filled, and the next train would probably have been filled by passengers from a train on the elevated railway. One specially instructive point in regard to bridge guard rails may be drawn from the ease with which the slow-running wheels mounted these inside guard timbers, the truck probably being slewed round. The timbers are of ordinary size, apparently old, and are sufficiently well secured, so that the wheels mounted instead of shifting them, but the edges are beveled or chamfered, thus reducing the effectual height somewhat. If two guard timbers had been used to each rail, as on the elevated railways, it would hardly have been possible for the wheels to slew sufficiently to climb the timbers. The guard timber opposite the inner rail of the curve is faced with iron for a few feet from the end, and this iron has been severely gouged by the wheel flanges at the point where the trucks shift on leaving the curve.

COLBURN'S PORTABLE DRILLING AND TAPPING MACHINE.

The use of portable drilling and tapping machines which can be operated at considerable distances from the countershaft and easily transferred from one piece of work to another is rapidly increasing. These tools are found especially convenient in shops doing a large amount of heavy repairing, as in railway locomotive and car shops, where very often drilling has to be done on parts in position which cannot be moved to the stationary drill press and would otherwise be drilled by hand. It is found, for example, that new locomotive cylinders can be drilled and reamed on the floor, near where they are to be applied, faster and more accurately with a good portable device than with most radial drill presses, and the heavy castings do not have to be moved so often. Such portable machines are also much used for drilling out and renewing staybolts, tapping staybolt holes and in bridge and boiler shops for reaming punched holes.



Colburn's Portable Drilling and Tapping Machine

The accompanying cut illustrates a tool of this kind manufactured by Mr. Albert L. Colburn, of New Haven, Conn. This tool is provided with a patent power transmitting device which enables it to be set up a long distance away and in any direction from the countershaft. The operation of this power transmitting device is quite clearly shown by the cut. This size of machine will drill holes up to 1⅛ ins. in diameter and will drive a 1⅛-in. tap in cast iron. It has four changes of speed for drilling and two for tapping, two of the speeds being used to back the tap out, which is done much faster than the tap is fed in. When the hole has been tapped deeply enough, the motion is reversed by simply shifting the handle shown on the cut just below the driving wheel. In drilling or tapping, the power can be instantly stopped by moving this handle to a central position. The feeding arrangement is entirely enclosed to protect it from dirt and damage. It also has quick return, which gives the free movement of the spindle up and down required for tapping, the tap feeding itself in and out of the hole the same as with a stationary drilling machine. The spindle has a feed of 6 ins. and the post is 36 ins. long. The radial arm is 12 ins. long and the clamps open 10 ins.

THE MINERAL RESOURCES OF THE UNITED STATES FOR 1893.

According to the tenth and last report of Mr. David T. Day, Chief of the Division of Mining Statistics, the total value of the mineral products of the United States in 1893 was the smallest since 1889. A comparison of values alone since 1884 would stand as follows:

1884	$413,989,105	1889	$583,886,965
1885	429,398,680	1890	654,506,161
1886	467,036,594	1891	657,988,969
1887	544,141,374	1892	688,687,712
1888	565,372,936	1893	609,817,495

As seen, the advance in value was steady and rapid, reaching a minimum in 1892, and in that year showing an increase of over 66% over the product of 1884. The figures for 1893 show a loss, or decline, of 11.44% as compared with 1892, and a gain of 4.67% of that year over 1891.

The decline was most marked in pig iron and structural materials, though most other materials also declined, the exceptions being gold, anthracite coal, aluminum and phosphate rock. The following table shows some of these differences in value and output for the two years 1892-93:

	1892 Quantity.	1892 Value.	1893 Quantity.	1893 Value.
		$		$
Pig iron,[1]	9,157,000	131,161,039	7,124,502	84,810,425
Silver[2]	63,500,000	82,099,150	60,000,000	77,575,757
Gold[2]	1,596,375	33,000,000	1,739,081	35,950,000
Copper, lbs.	353,275,742	37,977,142	337,416,848	32,054,601
Lead[2]	173,654	13,892,320	163,982	11,839,590
Coal, bitu.	113,237,845	125,195,139	114,584,796	122,751,618
Pa. anth.[4]	46,850,450	82,442,000	48,185,306	85,687,078
Lime, bbls.	65,000,000	40,000,000	58,000,000	35,960,000
P'trol'm "	50,509,136	26,634,196	48,412,666	28,932,326
Natural gas	.....	14,800,714	.....	14,346,250
Totals:		$		$
Non-met'llic	.....	379,971,473	.....	358,835,629
Metallic	.....	307,716,239	.....	249,981,866
Unspecified	.....	1,000,000	.....	1,000,000
Grand total	.....	688,687,712	.....	609,817,495

[1] Long tons. [2] Troy ounces. [3] Short tons. [4] Long tons.

This general decline, says Mr. Day, was only conspicuous during the last half of 1893, and is attributed to the financial depression and the consequent decrease in demand for consumption. But as considerable time is necessary for effecting the mineral industries and they are correspondingly slow in recovering lost ground, the effect will be equally pronounced in 1894.

The pig iron product alone declined in value, for 1893, as much as $46,000,000; and as a consequence of this we have a loss of nearly $14,000,000 in the value of ore mined, with a corresponding loss in the mining of limestone for flux and the production of coke.

Among structural materials of a non-metallic nature the decline from the previous year was also very considerable, showing a halt in building operations. The value of stone of all kinds declined nearly $15,000,000, or from $48,706,625 in 1892 to $33,865,573 in 1893. The decrease in natural rock cement was slight, the output of cement of all kinds being – 8,758,621 barrels in 1892, and 8,002,467 barrels in 1893. The total value of finished brick, tile and terra-cotta amounted, in 1893, to $67,000,000, the value of brick clay being placed at $9,000,000, or exactly the same as for 1891 and 1892. Notwithstanding the cyclone of

August, 1893, which wrecked the phosphate industry in South Carolina, the total output was 941,368 tons, against 681,571 tons in 1892, and the values compared as $4,136,070 in 1893 to $3,296,227 in 1892. The output of last year aggregated 438,804 tons from Florida and 502,564 tons from South Carolina.

A new steam turbine is being developed by the Altham Motor Co., of Fall River, Mass. A motor designed for street-car service is said to be of 30 HP. and to weigh about 2,000 lbs. It is said to run for 12 or 15 hours with a consumption of 20 gallons of petroleum.

The Chignecto Ship railway subsidy of $170,000 a year granted by the Dominion Government for 20 years expired on July 1, 1893, by reason of stoppage of work owing to financial troubles in England. Mr. H. G. C. Ketchum, Chief Engineer of the company, and Mr. A. D. Proband, M. P. for Glasgow, and Mr. A. R. Dickey, M. P., are now in Ottawa trying to induce the government to extend the concession. About $3,000,000 have already been expended upon the work and Mr. Proband says that the English stockholders have sufficient capital available to complete the work and have practically entered into a contract to this end with Pearson & Sons, a responsible English contracting firm. What they want now is a promise that the government subsidy will be revived if the work is completed within a given time.

The Robertson rapid-fire gun, now under examination by the naval ordnance board at Washington, D. C., is an American invention, differing in some essential details from other guns of the same class. It has two 30-in. barrels and uses the army .30 caliber cartridge. These barrels can be fired separately or together, and with both barrels a rate of 400 to 500 shots per minute is claimed. The gun is operated by a crank and at each discharge the barrels move forward upon guides to drop the empty cartridges. No cooling device is used as the inventor claims that the excessive heat escapes to a large degree during the forward motion of the barrels. The feed is a species of link belt in which the cartridges form the coupling pins between two layers of brass links. The gun itself weighs about 25 lbs. and it requires two men to operate it.

Postal trolley-cars are being tested by the Postmaster of Brooklyn, N. Y., on electric railways reaching the recently annexed towns and villages. The purpose of these cars is to facilitate the free mail delivery. Each car is 28 ft. long, with the interior divided into two entirely separate compartments, one fitted up as a smoking room and the other as a railway post-office. The cars cost about $1,900 each, and if the new mode of delivery is a success this trolley postal service will be extended.

A large electric water-power transmission scheme is under way at Montreal. It is proposed to develop about 15,000 HP. at the falls of the Richelieu River at Chambly, 16 miles from Montreal, and bids for the electrical machinery are to be opened on Aug. 15. The Chambly Mfg. Co., New York Life Building, Montreal, has the matter in charge.

The proposed New York canal improvements, according to the report of State Engineer Adams to the Constitutional Convention, would cost $20,293,000. This includes deepening the canals to 9 ft. from 7 ft.; lengthening 43 locks, the other 39 on the Erie Canal having already been lengthened at an average cost of $35,000 each, and in some cases raising the dams at the feeding reservoirs. The approximate estimate of cost for the several canals is given as follows:

Erie Canal	$5,310,000
Oswego	1,208,000
Champlain Canal	4,300,000
Black River Canal	8,880,000
Cayuga and Seneca	260,000
Oneida River Canal	335,000
Total	$20,293,000

The cost of cleaning the canals to their present depth is estimated at $955,000.

PERSONALS.

Mr. Edward S. Schurig has been appointed City Electrician of Omaha, Neb.

Mr. J. N. Ross has been appointed Acting Assistant Superintendent of the Southern Railway.

Mr. Ramsey, of Missoula, Mont., has been appointed Superintendent of the Butte, Anaconda & Pacific Ry.

Mr. W. S. McDonald has been appointed Engineer and Superintendent in charge of the Alton bridge of the Chicago, Burlington & Quincy Ry.

Mr. J. F. Holloway, Past President Am. Soc. M. E., has accepted the position of Consulting Engineer of the Snow Steam Pump Works, with office at 106 Liberty St., New York.

Mr. A. M. Van Auken, whose disappearance was reported in our last issue, is said to have been found in Detroit, Mich., in a partially demented condition, claiming the name of Chas. M. Hobbs.

Mr. Charles Howard Warren has been appointed General Superintendent of the Great Northern Ry., with which road he has been connected since 1881, his latest position having been that of Comptroller.

Mr. Edward H. Castle, who died in Chicago July 25, at the age of 83, was during the war appointed by Gen. Fremont as superintendent of military railways in the West, being in charge of the railways taken control of by the government for military purposes.

NEW PUBLICATIONS.

STEEL RAILS. By P. H. Dudley, New York. 8vo; pp. 40; illustrated.

This is a reprint of the very interesting paper read May 19 before the Scranton Engineers' Club, Scranton, Pa., by Mr. Dudley, whose name is well known in connection with the design, manufacture and testing of steel rails. The paper strongly emphasizes the necessity of such a design or section as will permit of rolling the heads at a low temperature, thus securing the closeness and compactness of grain requisite for good wearing qualities. Interesting particulars are given of rail tests and the desirable qualities of a good rail are given in the following brief sentence: "The safe, serviceable, all-around rail, as shown by experience, is one which is physically hard and tough, the metal of which does not readily flow or take a set in the track.

PARK AND BOULEVARD COMMISSIONERS OF KANSAS CITY, MO.: Report Embracing Recommendations for the Establishment of a Park and Boulevard System for Kansas City. Geo. E. Kessler, Engineer. 8vo, pp. 84; folding sheets of maps, diagrams and reproductions of photographs and other illustrations.

This is a comprehensive study of the subject named, with recommendations for about ten miles of boulevards and about 320 acres of large and small parks. One of the propositions is to provide a suitable outlook from the bluff over the railway and manufacturing interests and the Missouri River below.

GENESEE RIVER STORAGE SURVEYS: Reports of Martin Schenck, State Engineer and Surveyor: Report of E. Sweet, Consulting Engineer; Preliminary Report of Geo. W. Rafter, Engineer in Charge, to Martin Schenck, State Engineer and Surveyor: Report of Geo. W. Rafter to Campbell W. Adams, State Engineer and Surveyor. 8vo, pp. 107; illustrated.

The object of the proposed Genesee River storage is to furnish a supplementary water supply for the Erie Canal. Incidentally water for power might be provided if sufficient storage was secured. Two sites for a masonry and one for an earth dam are considered in the report, the most desirable height in any case being 130 ft. A masonry dam of this height would give a storage of 7,700,000,000 or 7,100,000,000 cu. ft., according to location, the corresponding costs being $2,400,000 and $2,600,000, or $312 and $366 per million cubic feet stored. The report contains an interesting account of the borings made at the dam site and tests of the same by water pressure. It also gives in detail some tests of concrete made to determine the relative merits of shale and harder stone, the shale being readily obtainable at the dam sites. It was found that the shale would not be suitable for the masonry of the main structure, but might be used in other parts of the dam with a saving of some $40,000. A topographical map of the dam sites is presented and alternative sections. Several views of the sites and of tests in progress are also shown.

LES TRAVAUX PUBLICS ET LES MINES DANS LES TRADITIONS ET LES SUPERSTITIONS DE TOUS LES PAYS. By Paul Sebillot. Paris: J. Rothschild. 8vo; paper; pp. 623; 435 illus.

The mining of ores and extraction of metals have always been a fruitful source of myth and fable. In the mountain countries of Europe, indeed, a veritable system of mythology has been woven around these industries, and every child's fairy-book is filled with the tales of gnomes and gnomides which have originated among the superstitious mountain folk. While studying these legends of the mines, the author of the book before even the most prosaic and practical of the works of man, and he conceived the somewhat novel idea of collecting the myths and legends which had become connected with that vast system of works to which the French apply the term "travaux publics," and which comprises the bridges, tunnels and aqueducts, the railways, roads and canals and all the similar commercial structures of modern civilization. The result has been a collection of folk-lore and archæology which is often amusing and always interesting and curious. No attempt to give a summary of the contents of the book would be satisfactory in a small space, but a fair idea may be obtained of the extent of the work from the statement that over 435 illustrations and 623 closely printed pages are devoted to the subjects mentioned. Many of the illustrations are reproductions from curious and rare prints of old structures and with the text afford some very interesting browsing to one who likes to learn about "old things" without going too deeply into their "ology."

TYPHOID EPIDEMIC IN MONTCLAIR, N. J.: Report by a Special Committee of the Montclair Club. Geo. A. Miller, Secretary Committee; Wm. L. Ludlam, Secretary Club. 15 pp.

This is a study to determine the cause and responsibility for the milk epidemic of typhoid fever at Montclair, N. J., discussed editorially in our issue of April 19, 1894.

SOCIETY PROCEEDINGS.

SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.—The next meeting will take place at the Kimball House, Atlanta, Ga., on Thursday, Aug. 16. The subjects for discussion will be as follows: 1, "Counterbalancing of Driving Wheels," R. P. C. Sanderson, L. R. Pomeroy, T. W. Gentry and A. W. Gibbs. 2, "Air-Brake Defect Cards," A. B. Corinth, W. T. Hamar and A. T. Hooker. 3, "Draft Sheets, Best Forms for Economy of Fuel," Jno. B. Michael, W. H. Owens and C. B. Gifford. 4, "Is There a Permanent Careening of Passenger Truck Bolsters, and if so, What is the Remedy?" J. D. McPhail, R. D. Swisher and W. H. H. Price. S. A. Charpiot, Sec.

ROADMASTERS' ASSOCIATION OF AMERICA.—The twelfth annual convention will be held in New York, Sept. 11, 12, 13, continuing for three days. Committees have been appointed and reports will be submitted on the following subjects: "Records and Reports of the Maintenance of Way and Departments," Chas. S. Churchill, N. & W. Ry.; "Track Joints," J. M. Meade, A., T. & S. F. Ry.; "Standard Track Tools," G. W. Merrill; "Inspection and Distribution of Track Ties," Garitt Davis, B., C., M. & W. Ry. Papers will also be submitted for the "Railway Age" premium of $200 on "The Best Methods and Appliances for Clearing Wrecks." The convention headquarters will be at the Broadway Central Hotel, 667 Broadway, and the business meetings will be held in a hall of the hotel, but the opening session will be in Tammany Hall. H. W. Reed, Pres.
W. W. Sharpe, Secy. and Treas.

ENGINEERS' CLUB OF INDIANAPOLIS.—This is the latest addition to the list of technical societies, having only recently been organized. The by-laws provide that four standing committees shall be appointed by the executive committee, to consist of three members each. Three of these committees are to present abstracts of current technical literature; one upon electrical and mechanical engineering, one upon civil and mining engineering and one upon architectural engineering. The fourth is a committee on programs for meetings and for the year. The annual meeting will be held on the first regular meeting night in January. Regular meetings will be held on the second and fourth Saturdays of each month. The club elected the following officers to serve until the first annual meeting: President, Morris M. Defrees; First Vice-President, T. O. Morris; Second Vice-President, W. B. Poland; Recording Secretary, H. A. Dill; Corresponding Secretary, Charles C. Brown; Treasurer, Rollin Defrees; Librarian, J. W. Brain.

COMING TECHNICAL MEETINGS.

NORTHWEST RAILWAY CLUB.
Aug. 14 Secy., W. D. Crosman, Ryan Hotel, St. Paul.
NORTHWESTERN SOCIETY OF ENGINEERS.
Aug 14. Secy., D. W. McMorris, Burke Blk., Seattle, Wash.
NEW ENGLAND ROADMASTERS' ASSOCIATION.
Aug. 15, 16. Boston, Mass. Secy., E. E. Stone, B. & A. R. R., Springfield, Mass.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Aug. 16. Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.
AMERICAN ASSOC. FOR THE ADVANCEMENT OF SCIENCE.
Aug. 16 to 23. Brooklyn, N. Y. Secy., W. Putnam, Boston.
AMERICAN FORESTRY ASSOCIATION.
Aug. 20 to 24. Brooklyn, N. Y. Secy., J. D. W. French, Boston, Mass.
SOCIETY PROMOTION OF ENGINEERING EDUCATION.
Aug. 20 to 23. Brooklyn, N. Y. Secy., Prof. J. B. Johnson, St. Louis, Mo.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Sept. 1. Secy., O. Von Geldern, 719 Market St., San Francisco.
WESTERN SOCIETY OF ENGINEERS.
Sept. 5. Secy., Thos. Appleton, Lakeside Bldg., Chicago.
ROADMASTERS' ASSOCIATION OF AMERICA.
Sept. 11, 12, 13. New York. Secy., W. W. Sharpe, Waycross, Ga.
ENGINEERS AND ARCHITECTS' CLUB OF LOUISVILLE.
Sept. 13. Secy., G. W. Shaw, Norton Building.
COMMISSIONERS OF PUBLIC WORKS.
Sept. 19. Buffalo, N. Y. M. J. Murphy, St. Louis, Mo.
AMERICAN WATER-WORKS ASSOCIATION.
Aug. 21 to 23. Minneapolis, Minn. Secy., Peter Milne, 95 William St., New York.
ASSOC. SUPERINTENDENTS OF BRIDGES & BUILDINGS.
October. Kansas City, Mo. Secy., S. F. Patterson, Concord, N. H.
AMERICAN INSTITUTE OF MINING ENGINEERS.
Oct. 2 to 6. Bridgeport, Conn. Secy., R. W. Raymond, New York.
AMERICAN SOCIETY OF RAILWAY SUPERINTENDENTS.
Oct. 20. New York. Secy., G. A. Hammond, Boston.

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The failure of a masonry structure through the action of temperature strains is almost unknown in the annals of engineering practice. The paper which we publish in another column describing the failure of a concrete reservoir in Ceylon through the strains produced by contraction and expansion is the only record of an occurrence of this sort which we now recall in engineering literature. In view of the rapidly-extending use of monolithic concrete construction this article is of no small interest and value, and deserves the careful study of engineers, especially those engaged on works in the far South.

A most interesting feature of the paper is the fact that when failure after failure had occurred in the structure, and the engineers in charge were apparently at their wits' end what to do, an opinion was asked of Sir John Fowler, of Forth Bridge fame, who, notwithstanding the fact that few or no instances are known of the failure of masonry structures from the action of internal strains, correctly diagnosed the cause of the trouble. It is an excellent illustration of the difference between a master mind and a mind of ordinary caliber. The plodder would have convinced himself that some defect in the foundation soil or in the quality of the masonry had caused the repeated cracking, and would not have had originality enough to search for some more obscure source of the trouble. The broader man saw at once that unusual and repeated failure must be due to unusual causes, and with the Forth Bridge experiments on the contraction and expansion of concrete fresh in his mind, he was prompt in finding the key to the riddle.

Many contracts and specifications omit to specify what will be done in case after completion of the work some important requirement is found to be unfulfilled. A notable instance of this is the common specification for pumping engines, which rarely name any basis of settlement in case the duty required by the specification is not attained. We call attention to this at the present time because some recent specifications have been brought to our notice which are explicit on this particular point. The specifications were drawn by Messrs. Potter & Folwell, of Pittsburg, for pumping engines to be erected at McDonald, Pa., (see Eng. News, Aug. 2, 1894, for detailed bids), and contained the following clause:

> If the test does not develop the duty guaranteed by the contractor, there shall be retained from the final payment an amount equal to the capitalized value of the additional amount of coal needed to operate the plant when pumping the quantity specified.

It is obvious that where such a provision as this, or others of similar character, can be inserted in a contract, bids can be submitted with less risk by a contractor, since he stands in no danger of the rejection of his work in case it fall slightly below contract requirement. Of course, where specifications respecting quality of material or workmanship are not met, many engineers will wish at least the option of totally rejecting the work; but where fuel efficiency or capacity is slightly defective, an equitable adjustment of price can easily be reached. The contract at McDonald was awarded on a guarantee duty of 55,000,000 ft.-lbs., based on an evaporation of 10 lbs. of water per pound of coal, the steam pressure to be 80 lbs. The contract was let to the Snow Steam Pump Co., of Buffalo, N. Y., which is to supply a direct-acting compound duplex engine of 2,000,000 gallons capacity for $8,675.

The often discussed question as to how far risks should be thrown upon a contractor is brought up anew by the experience on the Chicago drainage canal. At the outset of this enterprise it was determined to place all risks as to the character of the material upon the contractors. Only two classes of material were recognized in the specifications, the clause covering the matter being as follows:

> Classification of Material.—All material excavated under the provisions of this contract is to be classified under one or the other of two heads, viz., "glacial drift" and "solid rock." Glacial drift shall comprise the top soil, earth, muck, sand, gravel, clay, hard pan, boulders, fragmentary rock displaced from its original bed, and any other material that overlies the bedrock.
>
> Solid rock shall comprise all rock found in its original bed, even though it may have been so loosened from the adjacent underlying rock that it can be removed without blasting. . . . The contractor is to take all risk as to variation in the total quantity of material to be excavated, as well as in the relative amount of glacial drift and solid rock, and the sanitary district reserves the right to increase or decrease these quantities without in any way changing or modifying the terms of this contract.

Surely nothing could be plainer or more positive than this, and it may fairly be claimed that if it is possible by any wording of a specification to lay the burden of risk on a contractor for excavation, it was done in this case.

And now let us turn to the results. As our readers already know, the work had not progressed far when a large quantity of material was found so hard and solid as to require drilling and blasting, but actually a hardpan, made up of pebbles, gravel, sand and clay. The contractors demanded rock price for this material, stating, what was probably true, that they could not afford to take it out at the price per cubic yard which they had bid for glacial drift. The upshot of the controversy was that the contractors threw up the job and the contract was relet to them at 50 cts. for glacial drift, where their original contract was at 27 cts. and 28 cts. And now, as noted in our news columns, the same question has come up again wih reference to sections C, D, E and F; and although the trustees have refused to grant the contractors' request for a reclassification, it remains to be seen whether they can compel the contractors to do the work at a loss.

Of course, viewing the matter in one light, if we assume that the prices bid by the contractors covered the cost of excavating material moderately difficult to handle, they would have made large profits had the material proved much more tractable under the steam shovel than they anticipated. In justice, then, if they were to profit when the game went their way, they should submit to loss when it goes against them. But it is hard to weave a net of law that will hold a man to the prosecution of a great and costly work if every stroke of work means a loss to him. The usual result, therefore, when it is attempted to place all the risk on the contractor is, "Heads, I win; tails, you lose." In other words, the contractor either makes a princely profit, or, if the chances go against him, he is generally successful in making the party for whom the work is done stand some part of the loss.

In view of these facts, it is well worth the consideration of engineers whether the attempt to place the burden of risk on contractors for important works should not be strongly opposed, save in cases where the contractor can be held to full financial responsibility for loss, and that without the expense of a lawsuit.

It is strange how much time Congress can spare to the discussion of measures calculated to annoy or injure railway companies, when it has no time to consider bills looking to their better control and management. On Aug. 3 the Committee on Interstate and Foreign Commerce devoted an hour to the consideration of a bill which compels railway companies to own, or control by lease, all sleeping cars used in interstate business, and fixing a penalty of $10 per car per day for non-compliance. Several members are said to have expressed themselves "in favor of the principles embodied in the bill," but it is difficult to imagine how any just principle can be found in it. If a railway can furnish necessary facilities for traffic with greater profit to itself by contract with another company than by doing the work itself, it is its privilege to do so, provided no right of the public is interfered with. Congress might as well enact a law that every road must build its own locomotives or must not run freight cars owned by another company over its line. The clause in the constitution making void all laws which impair the validity of contracts will doubtless be effectual in preventing the passage of this foolish measure, should it ever pass beyond the committee room.

THE USE OF ELECTRIC MOTORS FOR DRIVING MACHINE TOOLS.

Within the last three or four years there has been considerable progress made in the use of electric motors for driving machine tools, and several quite large establishments now use this power for operating the whole, or part, of their lathes, drills, planers, etc. With the view of obtaining some information regarding the extent to which electric power was being used for this purpose, and of the satisfaction which it is giving, we have made special inquiries among the leading makers of machine tools in this country and among such manufacturers as were known to have had experience with machine driving by electricity. In most cases the firms answering the inquiry had not had sufficient experience to justify them in expressing an opinion or had not used electric power at all. A few, however, replied at some length, and the main points brought out in these replies are given herewith.

Answers were received from nine of the largest and most representative machine tool makers in the United States. Seven of these stated that they had not used electric power for driving tools and had not applied it to any tools of their make, although one firm stated that customers had used electric motors for driving tools made by them. Another of these replies stated that the firm had made some investigation of the subject, but concluded that the method was advisable only in isolated cases. This same opinion is expressed by another firm, which writes as follows:

> Regarding driving machine tools by electric motors, we will say that we have had no experience whatever in that line, but our investigation of the subject has shown that it adds largely to the first cost of the ordinary class of tools, and that there is no corresponding advantage in the producing capacity of the tool. We have, however, had the opportunity of observing its application to large tools, where they were isolated from convenient connections, and in such cases it is of decided advantage.

It would seem from these replies that manufacturers had not yet felt any very great demand for electric motor-driven tools on the part of their customers.

Of the two firms who report some experience with electric motor-driven tools, one writes as follows:

> SIR: We have been using motors for some time for driving isolated machine tools, and also for isolated lines of shafting, and it has its advantages as well as limitations. The cost for an electric motor to drive an ordinary tool is necessarily more than for a countershaft, and where great range of speed is not required it does not seem to us warranted, unless the fact that the tool is isolated or difficult of reach from a line shaft would make the cost of extending the line of shafting equal the increased cost of a motor. In some machines in which a great range of speed is desirable, we think driving by a motor and dynamo especially designed to give such speeds fully worth what it costs. For instance, we have recently built some drilling, boring and milling machines in which we have 30 speeds forward and 30 speeds backward, the change being made from one to the other with the greatest possible convenience, and the variety of work of which such a machine is capable gives this large number of speeds much importance. We are not yet prepared to say anything as to the cost of maintenance as compared with the countershaft. This

can best be determined after the system has had a much longer period of use. We do not see that the application of motors for driving should have any effect so far as breakdowns of the tool itself is concerned. We think there is greater liability to delays from the use of the motor in the present state of the art than there is with a countershaft, as every mechanic is familiar with the latter, while comparatively few can correct troubles in the former.

The second firm has made something of a specialty of electric motor-driven tools, and writes as follows:

We would say that up to the present time we have attached motors only to our engine lathes and radial drills, but are in a position to apply them to all of our engine lathes, upright drills, radial drills, planers, milling machines, shapers and brass working tools if ordered constructed in this manner. The increase in the first cost of the tool proper will average about one-quarter. Taking small machines where the price of the machine alone is $200 to $300, the motor will average from a half to two-thirds of the cost, but on large machines, such as planers and large lathes, the cost would be only about one-fifth. According to our figures, it is somewhat cheaper to maintain the tool driven by electricity than by the old methods, inasmuch as the only cost of keeping up the motor would be to replace the brushes from time to time, which would be much cheaper than the cost of belts, pulleys, etc. The liability to break down is certainly reduced 50%; in fact, a machine driven by a motor is not likely to break down at all, whereas if driven by belts from overhead shafting there is always danger of breakage of belts, pulleys, etc.

There is scarcely any limit to the degree of speed to be obtained from a motor-driven tool, and the ease with which the speed is varied is certainly a pleasure to the operator. He is not obliged to shift his countershaft belt and transfer the driving belt from one step on the cone pulley to another. All that is necessary to do is to push the lever backward or forward as the case may be. A tool driven by electricity can be placed at all times to the best advantage without regard to overhead fixtures. Shops are free from dust and dirt and are not darkened by belts, countershafts, line shafting, etc. We cannot speak too highly of this system, and we think it is only a matter of time when all well-regulated shops will confine themselves exclusively to motor-driven machinery. We are receiving a large number of inquiries for this class of tools, and have just completed a large 30-in. engine lathe for the Card Electric Motor & Dynamo Co., of this city. Very truly yours,

Lodge & Davis Machine Tool Co.

Cincinnati, O., June 6, 1894.

One of the largest applications of electric power to driving machine tools in this country is at the works of the De La Vergne Refrigerating Machine Co., of New York city. Here all tools in the erecting shop are driven by C. & C. motors, deriving their power from two Thomson-Houston 30 K-W. generators. Among these are several quite heavy machines, including a 10 × 10 × 20-ft. planer, driven by a 15-HP. motor, and a 15-ft. boring mill and a 62-in. Corliss cylinder boring machine, each driven by a 10-HP. motor. The smaller machines are driven a by 2-HP. C. & C. and Bilburg motors. All the motors are back geared, to bring the speed down to requirements, the armature speeds averaging 1,200 revolutions per minute, and are also belted from pulley to countershaft, instead of from armature shaft to intermediate pulley and from there to countershaft. To insure noiseless operation, rawhide or compressed fiber pinions are used. It was also found necessary to use a flywheel on the planer to insure a uniform speed in reversing. The company's reasons for adopting electric power are given as follows in a recent letter: (1) Lowest first cost, (2) modern practice, and (3) anticipated saving in running expenses.

Electric power is also used for driving large tools by the Southwark Foundry & Machine Co., of Philadelphia, Pa., and the Robinson & Rea Manufacturing Co., of Pittsburg, Pa. Each of these firms has a 12 × 12 × 25-ft. motor-driven planer, built by William Sellers & Co., who also use motors for operating many of their tools, and especially for testing the working of tools after their completion.

From the above information it will be apparent that the excessive first cost of electric motors is the main obstacle to the general distribution of power by electricity over large establishments. Except where different departments are very widely scattered, and the distances over which power must be transmitted are great, electric motors will be found to cost several times as much as the shafting and belting that they displace. Unless some saving in dollars and cents can be made which will pay a good interest on the extra investment, few manufacturers will care to incur this additional first cost. Under the circumstances existing in most manufactories it is difficult to see where any considerable saving in expenses can be made by the use of electric motors. It is common knowledge, of course, that the shafting and belting in a large establishment consumes a large percentage of the power generated, sometimes 40 to 60%; but, on the other hand, when we consider the loss between the engine and dynamo, the loss in the dynamo itself, the loss in the wire circuits, and, most important of all, the heavy loss in the motor due to the fact that it is commonly run under a greatly varying load and must be frequently starting and stopping, it will be found in most cases that the electric distribution system will cause quite as much loss of power as the simple shafting and belting.

Even under circumstances where it may be possible to save, say, 5 per cent. or so of power by the use of electric motors, the saving thus made will represent a comparatively small amount of cash, for it means only a saving in the coal pile, and the large item of attendance on engine, boilers, etc., and other constant expenses which constitute so large a part of the cost of power continue unchanged.

If the electric companies wish to see more rapid progress in electric power distribution, therefore, they must manage, in some way, to greatly reduce the cost of electric machinery. There is some reason to believe that this may yet be done. With all the materials from which such machinery is made selling at unprecedentedly low prices, it needs only reduction in the labor cost of such machines by the greater use of labor-saving machinery in their manufacture to bring about the desired result.

Such a cheapening in first cost, however, must not be accompanied by any deterioration in reliability and durability. If electric motors are to be substituted for the belting, shafting and pulleys, which can be set up and repaired by any shop, the old disease of burnt-out armatures must be made of the very rarest occurrence. A single experience of work blocked while a new armature was being procured from the manufacturers would be sufficient to cause many manufacturers to discard the whole electrical system forthwith. It is largely because so much improvement has been made in this respect in the construction of motors in recent years that they are able to compete at all with shafting and belts.

Of course no one rule can be made to suit all conditions, and there are special circumstances where electric motors may be found of peculair advantage. Where extensive and frequent changes of arrangement are likely to be made in an establishment, the changes in the power distribution system can be made at much less cost if the electric system is used for power distribution. Again, where protection from fire is of especial importance the different departments can be isolated in separate buildings, placed far enough apart to give substantial protection, and electric power transmission will be no more difficult than if they were close together. Many plants, too, are operated, and are to be operated, by water-power in future, transmitted over distances where other methods are quite impracticable. In all such plants the driving of separate departments, and, to some extent, of independent machines, by separate motors will of course be the usual practice.

LETTERS TO THE EDITOR.

MOVABLE DAMS ON THE KANAWHA RIVER.

Sir: Referring to the paper by Mr. Addison M. Scott on this subject, read before the American Society of Civil Engineers on May 2, and abstracted in your issue of May 10, some additional particulars respecting the use of movable dams in this country may be of interest.

There are at least 14 varieties of movable dams in actual use to-day; and those who may have had the good fortune to have seen the fertility of invention displayed in the French exhibits at the Centennial or at the Exposition Universelle at Paris, 1889, or still later at Chicago last year, can readily understand that the end is not yet.

The aim of all these devices, as stated by MM. Hagen & Becker, is to provide a gate or wicket which may be operated by the pressure of the water whether standing or flowing, and which can be manoeuvred with slight power and in the least time. To meet these requirements there are the Bear trap (American), flashboards as used on the Riom, Thenard shutters, Thenard as modified by Fouracre, Poiree needle dam, Chanoine (1852), Desfontaine, Boule, Bruno (American)t Cuvinot drum wickets, Krautz wicket with pontoon, Cairo gates, Girard shutters, Janich combined trestle and wicket, Parson's hydraulic gate, and others.

The economy of the Pasqueau system is stated by the author to be only $2,000 on a pass 248 ft. long, yet the actual saving in construction at the Davis Island dam by the introduction of the hurters, as compared with the proposed dimensions of the tripper bar and appurtenances for the lock, was nearly $30,000 for this one structure, while the entire rights to the use of this valuable invention were obtained for the United States by an award, by the Court of Claims to M. Pasqueau, of only $20,000, which was the price (100,000 francs) which he had proposed to Colonel Merrill for his invention, provided he was not obliged to have recourse to the courts to obtain compensation.

The utility of the double-stepped hurter can hardly be overestimated, for it was evolved under peculiar circumstances and at a time when, but for its use, the government must have experienced the mortification of a lamentable failure. The original project at Davis Island was designed with passes and weirs, each 400 ft. in length, to be operated by the Chanoine tripper bars, making each bar over 200 ft. long with 50 wickets 13 ft. high to be pulled down. This was stated in the testimony before the court to be beyond the practicable limit. Mr. Scott places this limit in his paper at about 300 ft., but even 400 ft. was strenuously opposed by the navigation interests as being exceedingly dangerous and an obstruction to the large coal floats navigating the Ohio River, so that after it was found that the Pasqueau improvement was so simple and applicable, the pass was extended to 559 ft. and the weirs were made 224, 224 and 216 ft. long, respectively, giving a total length without pier or lock of 1,223 ft. and making it the longest movable dam in the world.

Concerning the advisability of extending the use of this system to our American rivers there can be no question, as the experience of our worthy president on the Kanawha has demonstrated that they are beneficial and practical, while more certain in operation and costing less than the fixed dams. It is also worthy of note that the railroads bordering the river were at first violently opposed to its improvement, on the ground that it would detract from their resources by enabling the coal to be moved more cheaply by water; but they have become converted to the truth of the paradox that navigable waterways are beneficial to railways, and are now the warmest advocates of a continuance of the improvement. Were further evidence needed, we have only to look at the results in France, Germany and Belgium, to be fully convinced of the beneficial and economic advantages of cheap water transportation and the efficiency of the system of movable dams.

A tolerably full history by the writer, supplemented by Col. W. E. Merrill, with illustrations of tripper bars and hurters, will be found in vol. IV., paper XXI., pp. 305 to 342, of the Proceedings of the Engineers' Club of Philadelphia, published in 1885, when M. Pasqueau was corresponding with a view to obtaining compensation for the application of his invention to the rivers of this country.

More complete descriptions of movable dams will be found in the late editions of Mahan's "Civil Engineering," revised by Captain Mahan, U. S. Engrs., resident engineer of the Davis Island dam, and in Executive Document No. 78, House of Representatives, 43d Congress, 2d Session, as well as in the Reports of the Chief of Engineers for 1880, et seq.

Very truly yours,

Lewis M. Haupt, M. Am. Soc. C. E.

Philadelphia, Pa., Aug. 1, 1894.

PEW'S FORMULA FOR EARTHWORK COMPUTATION.

Sir: I am much interested in the controversy between Mr. P. H. Philbrick and Mr. Arthur Pew on p. 73 of your issue of July 26. I find that I will have to come into this controversy, as I have among my papers exactly the same formula for calculating earthwork quantities. In the year 1874 or 1875 I worked out tables and blueprinted them for the use of my assistants, and I afterward worked out and extended them with the view of publishing them, when carried far enough to cover all bases or roadways. Owing to press of business and dropping out of the line of earthwork computations, I had put off the matter from time to time, thinking that at some period of leisure I would take it up again. My formulas have only one multiplication, and the other operations are merely by addition and subtraction. The quantities in my tables are all in cubic yards, and can be taken at once from the table, except when the correction for transverse slope is necessary, i. e., when the sum of the side heights is greater or less than double the center height, in which case it is necessary to multiply the tabular number by the difference and add or subtract, as the case may be, from the cubic area column, found for the center cutting; this process I call the end area correction, after adding the two corrected end areas together (which are in cubic yards direct from the table).

I then make the correction for longitudinal difference of ends from column "D," which is calculated from $\frac{(H-h)\,(H-h)\,r}{3\times 27}\,L.$ Or, as Mr. Pew has it, $\frac{d^2\,r}{3}\,L.$

L in my formula is taken as ½ ft., so that when two cubic end areas are added together it gives the cubic contents for a prism 1 ft. long, so that it is only then necessary to multiply by the length of station to com-

plete the result. If stations are 100 ft., all that is necessary to be done is to point off two places of decimals.

Now as we are all three working on the same line, and are all three going to "write a book," would it not be better for us to form a "trust" or "pool our earnings," like the railroads we have built with our independently developed but identical formulas. Let us have some compassion on the profession. Stop, gentlemen, for a moment and think of what we are about to inflict on our fellow-would-be workers these "troublous times," and spare the long suffering but patient "transit chasers" three more "long-felt wants." Our tables may seem to be a blessing to the tired and overworked resident engineer when his "estimate day" comes; but we may be sure they will not increase his pay. On the contrary, if the ever-considerate Chief "gets onto" the merits of our "New, Improved Lightning Time and Labor Saver," that worthy official will simply add a few more miles to each residency.

I remember many years ago when I was young in the profession and had my head full of the above-mentioned formulas and tables, my inventive genius was aroused and saw the urgent necessity of discarding the "old fogy" methods and instruments and devising something up with the times. After my work on the tables I turned my attention to devising a better way to do the cross-sectioning in the field, and a new-fangled level rod was the result. It was a long pine "self reader." On one face was the usual graduations, feet, tenths and hundredths; on another side was imbedded a level bulb; on another face the half roadbed for standard fills was laid off from the lower end, on the space was painted what base it was; from the base out to the end of the rod the graduations were marked the same as the levelling face, except that each foot of graduation was 1½ ft. The fourth side of the rod was graduated in the same way, except that the base was for cuts.

With this rod, work was carried on as follows: An assistant, if I happened to be so fortunate as to have one, was put at the level and called out the rod readings at center stake. The center cut was found and while one boy marked the center stake, the other laid the rod down with level up and found the difference between side and center; the cut was called out to the stake marker, and the driver simply set the side stake at the same figure on the rod that was marked on the stake. Thus the chief of party was not interrupted while figuring out his next grade elevation or recording his notes by repeated appeals at "critical" moments, such as "How far out?" "How much did you say?" and numerous other interrogations. The rod worked like a charm; no tape lines fluttering in the wind or tangled around one's legs; no calculations as to how far out; no pegging awls or knives to stick in center stake and pull out just at the wrong time. In fact the scheme worked so finely that we soon were able to do our quota of work in less than half the time required by the old plan. Then on hot days we would curl up under a shady tree and take two or three hours for dinner or a refreshing swim and go back to camp with a book full of notes. Our limit was only in the matter of stakes. The stake maker had to toil on at his work while the other "boys" lay in the shade. I was very proud of my invention and was rewarded—but not financially. They said I was getting along so nicely that I could just go ahead and stake out the whole road. The was the first and last rod of that kind ever made—by me at least.

In conclusion, let me ask, How will our "improved tables" affect mankind? The first one hit will be the meek and patient contractor. Our tables hit him, hard, harder, hardest, as the difference in end cuts increases. At present writing (being one of the aforesaid "meek and patient") I am decidedly in favor of the good old "end area method." "With all its faults," I would love it still more, were they even greater, when estimate day comes round. Let us, therefore, try and effect a compromise of some kind. I know our "fellows" will approve our efforts to that end. If this cannot be done, however, let us fight it out to the end, though it take three books to do it.

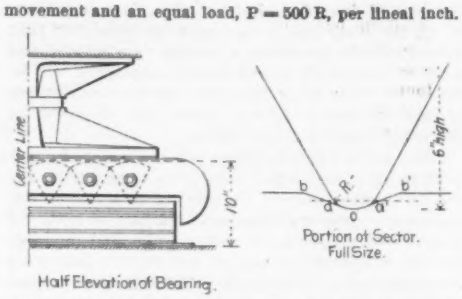
Yours most truly, C. L. Cornwell.

Louisville, Ky., July 31, 1894.

THE THOMAS EXPANSION BEARING FOR BRIDGES.

Sir: In connection with the standard expansion bearing designed by Mr. Geo. S. Morison, which was described in your issue of Dec. 7, 1893, the sector bearing designed by me and shown in the accompanying drawing may be of interest. This bearing consists of a nest of cylindrical steel sectors working between two bearing plates. The top bearing plate rests on the cylindrical surface of the sectors, while the sharp edge of the sectors works in planed grooves in the bottom plate, and, as will be seen from the enlarged drawing of one of the sectors, this edge is rounded. The advantages which I claim for my bearing over the segmental bearing are:

(1) The height and weight of the sectors are but one-half of that of the segments for an equal freedom of movement and an equal load, P = 500 R, per lineal inch.



With the height of the sectors the same as that of the segments, 12 ins., the freedom of motion is twice as great, the weight of the sectors one-fourth smaller, and the angle of oscillation for the same expansion is but one-half as great.

(2) The indentation of the top surface of the sector will be the same as that of a segmental roller with the same radius, provided there is any indentation, while the indentation of the lower surface need not be feared, for if we suppose the chord a a' of the arc a o a' is ¼ in. long, the pressure per square inch will be 500 × R × 4 = 500 × 6 × 4 = 12,000 lbs, which is less than the elastic limit of steel.

(3) The open space between two sectors is larger than that between two segments so that the accummulated dust is more easily removed.

(4) The stability of the sector will be perfect and permanent if, before erecting the structure, the sectors are properly inclined according to the average expansion for the allowed temperature. By reversing the sector, with the edge to the top, it will be naturally stable and offer little danger from turning over, but experience has proved this to be unnecessary.

The first use of this sector bearing was made in 1876 on a single track railway bridge of four 215-ft. spans over the Maese River, in Holland, on the line of the Antwerp-Gladbach Ry. The results have been very satisfactory. I have not patented this bearing, and all are free to use it. Yours truly, E. J. Thomas.

Montreal, P. Q., Dec. 19, 1893.

THE PROPER COLOR FOR SAFETY SIGNALS.

Sir: I wish to present for the consideration of your readers the idea that it is dangerous to use a white light as a safety signal, and that, reversing present practice, red should be the color for safety.

Let any one who doubts my assertion take position beside the engineman of an in-bound train in Chicago and try to satisfy himself as to whether the white lights he sees are safety signals or irrelevant street lights. How different it would be if the safety indication were given by a bright red light standing sharply defined and separate from all other lights. I think a very few trials will convince almost any one that a white light for safety is a poor reliance, to say the least.

A second important point is the certainty that any breakage, either accidental or malicious, will convert a danger signal into a positive safety signal. It is surely no impossible thing for a severe storm of hail to break out the colored glass at an interlocked crossing, and at the same time so clog the derail that the operator will find himself unable to close it in front of an approaching train. The broken glasses say "All right," however, and the engine is in the ditch before the towerman has had time to find the trouble. Or under cover of a dark night a maliciously disposed person could break out the glasses and block the derail with exactly the same result. Surely there is something wrong with a system that permits such accidents.

"A chain is no stronger than its weakest link." We create a chain of block signals with track circuit and all the latest improvements by which the signal is guaranteed to go to danger; but of what avail is all this expensive precaution if a broken piece of red glass allows the danger position to show a white light? And yet we go calmly on, allowing the safety of lives and property to depend on the strength of a piece of glass. We are simply going directly contrary to the fundamental rule of good signaling practice, that a break of any kind shall create a danger signal.

But now suppose we simply change our rules, so that a broken red glass will have its proper meaning and will not say safety, while all else is in the danger position; change our lamp brackets so that the lamps will shine through the red glass when the blade is down to a full safety position, and exchange the lenses in our switch lamps so that the red lens shows where the white one does now. As to cost, the only possible expense would be the printing of new rules, for there would not be a cent's worth of new material needed, and the work would be done by labor already on the ground, and by a little preparation could be made universal on some preconcerted day. As to confusion, the change is so radical that there is no possibility of error; because the runner who permits himself to relax his attention would be startled into wideawake alertness by the presence of the red light, and he would at once remember the change and realize that it now meant absolute safety.

Another advantage would be that, whereas now a badly adjusted semaphore which only comes a quarter of the way down shows as white a light as the best, with the proposed change a red light could not be shown unless the blade was within 10° of perfect.

Signal Engineer.

Toledo, O., July 10, 1894.

(The danger of confusing the safety signal from the white lens of a switch or semaphore lamp with the light from a street or other ordinary lamp is a real one; and, as our correspondent says, is contrary to the accepted rule that a safety signal should be positive and unmistakable. Apparently, however, it would be jumping from the frying pan into the fire to make the present safety signal a danger signal; for how many hundred enginemen would there be, who, trained in long years of habit to regard white as the safety signal, would fail to stop when it flashed up ahead. Again consider the strain on an engineman's nerves when running into a city, were the change our correspondent suggests put into effect. Every street lamp or luminous window that came in line with his lookout ahead he would imagine to be a danger signal. And the consequence would be that his attention would soon be fatigued, and when the white switch lamp did flash up before him, he might not detect it until too late. The need of a positive color for the safety signal is appreciated, and several important roads in this country and abroad have met it by making green the safety color. This meets the chief objection to the present common use of white for safety that our correspondent raises, and leaves red as the danger color, a position in which it is now so firmly rooted that no change is ever likely to be made.—Ed.)

THE WATER TANK FAILURE AT SALEM, S. D.

An elevated wooden tank, connected with the water-works of Salem, S. D., failed on July 13, 1894, as noted in our issue of July 26. We are indebted to Mr. M. A. Blackburn, engineer and superintendent of the water-works, for the following particulars regarding the tank and its failure:

The foundation consisted of six masonry piers, each 11 ft. long, 18 ins. thick at the top, 3 ft. thick at the bottom and 3 ft. deep. On these piers were laid 12 × 14-in. timbers 10 ft. in length, upon which stood twelve 12 × 12-in. vertical posts 20 ft. high. These were braced by 6-in. timbers, and tied by ¾-in. iron rods. The posts were capped by 12 × 12-in. timbers, two 28 ft. and two 16 ft. in length, which in turn supported 2 × 14-in. joists, 12 ins. c. to c. The joists were not bridged, but were doubled beneath the central part of the tank. It was these joists that crushed and lopped over, causing the hoops of the tank to burst. A double floor of 1-in. boards was nailed to the joists, and upon this floor 4 × 6-in. "chime-posts" were placed to support the tank bottom. As the stone foundation, trestle-tower and cap timbers were level and plumb after the wreck, it is hardly possible that any defect in those respects caused the trouble. The tank was a regular 16 × 24-ft. structure. Two eye-witnesses, one the assistant engineer, say they heard a noise as though some one was pounding on the hoops. On looking up they saw the tank settling to one side slightly. It then settled down and at the same instant the hoops began bursting from the bottom and ripped upwards. The staves and water went in all directions, and some pieces of hoop and staves landed 150 ft. away. Fortunately no one was hurt. The pump house directly at the side of the tank was completely demolished, but the machinery was only slightly damaged. The tank is being rebuilt with joists 3 × 10 and 10 × 10 ins., spaced 8 ins. c. to c.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Option of Town to Buy Water Company's Plant.

Where a water company's charter gives the town the right to take the franchise and property on payment of the actual cost, the town's vote to take the plant completes the purchase, and its right to stop further extension of the plant accrues then, not when payment is actually made or tendered.—Rockport Water Co. v. Rockport (Mass.), 37 N. E. Rep., 168.

Right of City to Abate Public Nuisance.

The erection within the "fire limits" of a city of a building from forbidden material is a nuisance which may be abated by the city with notice to the owner. Where such building has been erected after the fire limits have been established, the city may destroy it without incurring any liability. The ordinance of a city establishing "fire limits" is the best evidence of what such limits are.—Miller v. Sergeant (App. Ct. of Ind.), 37 N. E. Rep., 418.

REPAIRS TO THE MALIGAKANDA SERVICE RESERVOIR, COLOMBO, CEYLON.*

By Henry Ewart, M. Inst. C. E.

The Colombo water-works were designed by the late Mr. J. F. Bateman, Past-President Inst. C. E. The late Mr. A. W. Burnett, M. Inst. C. E., and a staff of assistants, superintended the construction of the works on behalf of the Ceylon Government, and was occupied with the preparation of a paper descriptive of the works at the time of his death.

A description of the Maligakanda service reservoir as originally designed has been given to the Institution by Mr. W. Fox, M. Inst. C. E., in the discussion of a paper on "Covered Service Reservoirs."** The reservoir is situated on rising ground, the level of the original surface being 70 to 75 ft. above the sea-level. The formation is that known as "cabook" or "laterite." This formation is usually hard near the surface, and varies from gravel in some places to a rather perishable rock in others. It is reddish in color, owing to the presence of oxide of iron. The rocky portions are extensively used for building purposes, and are excavated in blocks about 18 × 9 ins., 6 ins. thick. A few feet below the surface, the cabook becomes plastic, somewhat resembling clay in consistency, but permeable by water. White particles also appear intermingled with the red. When exposed in the sides of excavations, it will stand at inclinations nearly approaching the vertical, and sometimes actually vertical without slipping. The capacity of the reservoir as originally constructed was about 10,800,000 U. S. gallons. The walls were entirely of concrete, the inner faces being vertical and the outside having a batter above ground of 5 ins. in 1 ft. The floor was of concrete 1 ft. thick, rendered throughout with neat cement ½ in. thick, and laid with a fall of 6 ins. from the northern and southern sides towards the center of the reservoir. Before the site of the reservoir was acquired, numerous pits had been excavated upon it, in order to obtain cabook blocks for building purposes. These pits were of various depths, and were partly filled with rubbish.

In deciding the levels to be adopted for the foundations of the walls, three objects were kept in view, viz., to remove all rubbish and soft material, to avoid frequent changes of level, and at the same time to avoid moving more sound material than was necessary. Having regard to these considerations, it was found necessary to excavate the foundations of the northern and eastern walls down to the same level as that of the floor, while the foundations of the southern and western walls were fixed at 5 ft. 6 ins. and 2 ft. 7 ins. respectively above the foundation of the lowest part of the floor. Terraces or benchings 7 ft. wide were left at the feet of the southern and western walls, and the drops from the terraces to the floor were battered 6 ins. to 1 ft. The concrete flooring was carried over the benchings and joined into the walls. The changes of level between the foundations of the different walls were made in steps 2 ft. on flat, with rises of 1 ft. In every case, these steps were made as an addition to the wall with the shallower foundation.

The roof consists of two tiers of concrete arches, rising 18 ins. at the centre of the span. It is supported by 121 cast iron columns spaced 16 ft. c. to c. The arches run north and south, and span the spaces between the columns from east to west. The lower arches spring from cast iron girders bolted to rectangular flanges at the tops of the columns. The upper arches spring from wrought iron rolled beams which rest on concrete pillars placed immediately over the columns. The lower arches are 9 ins. thick throughout, and each arch is pierced at the crown by a row of ventilating holes 16 ft. apart, to permit the passage of air when the water in the reservoir rises or falls. The thickness of the upper arches is 7 ins. at the crown, increased towards the springing to 15 ins., so as to give a depth of 6 ins. of concrete over the top of the rolled beams. The side thrust of the arches is taken up by wrought iron tie-rods. Ventilation is provided between the upper and lower arches by grated openings in the parapet walls. The rain water which falls on the roof of the reservoir flows into cast iron sumps, which are placed against the northern and southern walls in the hollows of the upper arching. The sumps are connected with cast iron pipes which rest on the lower arches and discharge the rain-water into the overflow stand-pipe. From this description it will be inferred that the greater part of the reservoir is above ground.

The work of excavation was begun in June, 1882. The sites of the walls were covered in by a roof of "cadjans," or thatch made by interlacing the fronds of cocoanut leaves. The thatch was supported by a framework of bamboos, and as the walls were built up the roof was raised from time to time so as to allow sufficient space to work beneath it. The walls were formed between facings of concrete blocks, with the exception of the vertical portion below ground where blocks were laid only on the inner face, the outer face being formed for the most part by the side of the excavation. The blocking on the inner side was laid on a bed of concrete, which projected about 15 ins. beyond the face so as to form a tie for the concrete floor. The concrete between the facings was laid in layers, breaking joint both horizontally and vertically, and the surface was carefully cleaned and covered with a bed of mortar at the beginning of each day's work. Before the excavation had been carried quite down to foundation level, the concrete bases for the cast iron columns were put in. The remaining material was then taken out in small areas, and a depth of 4 ins. of concrete was spread over each portion of the floor as soon as it was laid bare, so as to form a protection until the whole area could be covered in by the permanent roof. The waste pipe was laid at this time to carry off all rain-water. The concrete for the face blocks and floor, and for the bases of the columns, was formed of 4 parts by volume of sand to 1 part of Portland cement. The face blocks were made 20 ins. long, 10 ins. on bed and 8 ins. deep, this being the largest size which could be conveniently handled; they were laid with a course of headers to two courses of stretchers.

The concrete for the walls was formed by first mixing stone and sand in about equal volumes and adding one part of cement to six parts of mixed stone and sand; the concrete was also thoroughly grouted while being laid. The stone used was gneiss rock, broken to pass through a ring of 1½-in. diameter. The sand was obtained partly by dredging from the River Kelany, and partly from the seashore. The cement was supplied to the contractors by the government. The broken

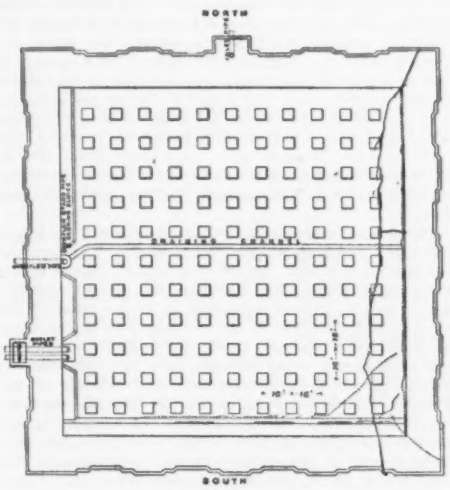


Fig. 1. Plan of Maligakanda Reservoir, Showing Cracks of October, 1885.

stone, which contained a good deal of fine dust, was thoroughly washed before being used. The concrete was made on planked stages placed on the ground at convenient points outside the reservoir; it was carried up in baskets (chiefly by women), suitable gangways being constructed for the purpose.

The walls had been built up to the level of the lower girder-beds by the end of May, 1885; the cast iron columns were next erected and were temporarily braced with timber and bamboos. The bed-plates were first carefully levelled, their positions being adjusted with iron wedges, and the space underneath thoroughly packed with mortar. The columns were erected and bolted together by means of a traveling stage. The lower girders and tie rods were then fixed, each girder being bedded on lead bearings ½ in. thick. The centering for the arches was hung from the girders by means of wrought iron slings. River gravel was substituted for broken gneiss in the concrete for the arches, as it was more suitable for the less bulky work. The arches were turned over the full width of the reservoir in lengths of 8 ft. measured along the girders. Three 8-ft. lengths (one at the northern wall, one at the southern wall, and one at the center) were omitted temporarily in order to give light for completing the floor. Both tiers of arching, together with the concrete pillars, upper girders and tie rods were erected, first over the southern half of the reservoir, and subsequently over the northern half. The concrete of the roof was protected from the sun by a temporary cadjan roof, which was constructed to cover half the area of the reservoir, and was moved as required. When the roof (with the exception of the three spaces mentioned above) had been completed, the floor was laid and rendered with ½ in. of neat cement.

The water was first admitted on Sept. 30, 1885, and rose until Oct. 6, when a depth of 12 ft. 11 ins. had been attained. The inflow from the main pipe was then stopped. Rain fell on Oct. 6 and 7, and entered the reservoir through the openings which had been left in the roof, and increased the depth of water 2 ins. From Oct. 7 to 10 no rain fell, and the level of the water remained constant, showing that up to that time the reservoir was perfectly water-tight. Water was again admitted till Oct. 16, when a defect was discovered near the southeastern corner of the reservoir, the water then standing at a depth of 24 ft., or 16 ft. below top water level. The reservoir was then emptied, when it was found that there were cracks in the concrete flooring along the lines shown in Fig. 1.

The cracks in the northeastern and southeastern angles of the walls extended upwards to about 22 ft. and 10 ft., respectively, below top water level, after which they branched off and disappeared in the joints of the blocking. At the northeastern angle, the crack did not penetrate far into the wall. The crack at the southeastern corner was not perceptible on the outside of the wall at the time the defect was discovered, the first thing noticed being a small quantity of water oozing through at one of the joints. By the following day, however, it could be traced up the outer face of the eastern wall. It was subsequently found, when the wall was cut through, that this crack was barely traceable in the body of the concrete. The width of the crack in the floor running parallel to the eastern wall was nearly ¼ in.; the other cracks in the floor and the benching ranged in width from nearly ⅛ in. to mere lines on the surface of the cement.

When the quantity of water entering the reservoir had been calculated from the observations taken at the inlet gage, and compared with the quantity shown by the actual rise of the water level, it became evident that for some time before the defect was discovered a considerable volume of water must have been leaving the reservoir. It therefore seemed probable that the floor had first cracked, and that the water percolating through the cracks had so far softened the inner side of the foundation as to cause a slight settlement and produce the cracks in the angles of the walls. None of the concrete column bases had moved in any way, although three of them were within the area where the cracks in the flooring near the southeastern corner occurred.

In order to repair the damage, it was decided to cut out the concrete wherever the cracks extended, both in the angles of the walls and on the floor, to remove the cabook under the floor and walls wherever it might be found to be damaged by the water, and to fill the excavations with concrete. As precautionary measures the benchings at the southern and western walls were removed entirely, and the angles between the floor and walls, as well as the vertical angles between the walls themselves, were rounded off and considerably strengthened by curved footings, Fig. 2. A foot of concrete was added to the floor, and the surface of the new concrete on the floor and in the curved footings was rendered with neat cement ½ in. thick. There was no trace of any cavity or washing away of the material in any part of the foundations, and, with the exception of a portion of the cabook taken from under the floor and benchings near the southeastern corner, there was no sign of any damage or deterioration having been caused by the passage of water. The concrete in the footings and new flooring was made with the same kind and quality of materials, and mixed in the same proportions as the concrete in the walls already described. These repairs were begun in April, 1886, and were completed early in the following November.

On Nov. 30, 1886, the water was again turned into the reservoir, and by the evening of Dec. 6, had risen within 20 ft. of top water level, or 19 ft. above the new flooring. The inflow was then stopped for 48 hours, during which time the level of the water remained perfectly unchanged, proving that at this period the reservoir was water-tight. Filling was resumed on the evening of Dec. 8 and continued till the evening of Dec. 12, when the rate of rise of the water in the reservoir was observed to fall off slightly, although the inlet valve had been carefully regulated to deliver a constant quantity. The inflow was therefore stopped, and it was then found that the water fell at the rate of ¼ in. per hour, indicating an escape of about 5,640 U. S. gallons per hour. At this time the water stood 10¾ ft. below top water level, or 28¼ ft. above the new floor. The reservoir was again emptied, and it was then found that there were slight cracks near the center of the curved footings, running horizontally round all four sides of the reservoir. The cracks, though clearly traceable as lines on the surface of the cement rendering, were not of measurable width, and they could not be traced below the rendering in the body of the concrete.

It was decided to cover the surface of the footings with asphalt over the width affected, grooves 3 ins. to 4 ins. deep being cut on the lines of the principal cracks. This work was completed by the end of January, 1887. By this time, the water from the impounding reservoir had been laid on to the town; but as very

* Reprinted from Proc. Inst. C. E., vol. CXVI., Session, 1893-4, Part II.

** Proc. Inst. C. E., vol. LXXIII., p. 49.

few connections had, so far, been made, the greater part of the quantity delivered by the main pipe was available for filling the service reservoir. Filling began on Feb. 12, the operation being suspended on Feb. 13, 15 and 16.

It is certain that up to the morning of Feb. 16, at which time the reservoir was filled to within 5 ft. of top water level, the walls and floor were perfectly water-tight. Filling was continued up to 3:55 p. m. on Feb. 16, when a serious fracture occurred, the water then standing at a depth of 38 ft. 2 ins., or 10 ins. below top water level. The fracture began at the top of the wall at the northeastern corner, and was followed, a few minutes later, by a fracture in the top of the southern wall, about 16 ft. from the inner face line of the eastern wall. The cracks were clearly seen to begin at the top of the wall and to travel gradually down to the ground, water pouring out as they opened. They did not reach the level of the ground

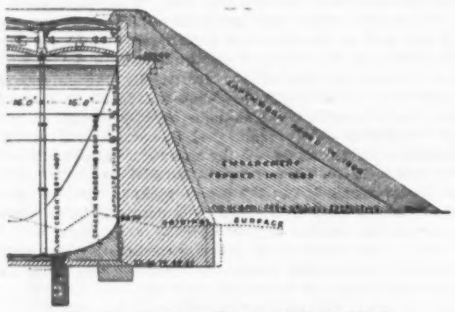


Fig. 2. Section Through East Well.

until a quarter of an hour after their commencement at the top of the wall. A much smaller crack occurred at the center of the eastern wall, but it was not of sufficient magnitude to allow any water to pass during the time that the reservoir was being emptied. The scouring sluice was opened as soon as the fracture at the northeastern corner began, and the reservoir was emptied by the following morning. It was then found that the fracture extended from north to south, completely across the floor of the reservoir. The cast iron columns and their concrete bases were uninjured, and the roof arches, though cracked longitudinally in many places, were perfectly stable. The cracks in the floor and the lower part of the walls were ⅝ to ½-in. wide at the northern, and ¼ in. wide at the southern side of the reservoir. On and after Feb. 18, the cracks measured at the top of the walls were ⅝ ins. wide at the northern wall, and ⅜ in. wide at the southern wall; but on Feb. 17, soon after the reservoir had been emptied, they were respectively ¾ in. and ½ in. wide, and immediately after the fracture occurred they were considerably larger. A comparison of levels taken in February, 1887, before filling the reservoir with levels taken after the fracture occurred, showed that there had been no subsidence. In order, however, that there might be no possible doubt as to the solidity of the foundations, borings were taken on each side of the reservoir to a foot or two below sea level. The material brought up was in all cases sound cabook, and the bore holes, though without tubes or lining of any kind, showed no sign of closing up.

Sir John Fowler, Bart, Past President Inst. C. E., having been consulted by the government as to the causes which had led to the serious fracture of the Maligakanda reservoir, and the measures that should be adopted for its repair, reported that the strains caused in concrete by varying temperature, due to the action of a tropical sun on exposed concrete walls, were quite sufficient to account for what had occurred. Extensive experiments had been made in connection with the construction of the Forth Bridge to ascertain the limits of expansion and contraction in cement concrete; and adapting the experience thus gained to the conditions existing at Maligakanda, Mr. Fowler was of opinion that the walls were subject, while the reservoir was empty, to a tensile stress of at least one-third of their ultimate resisting power, and that the stress added by the pressure of the water was sufficient to cause fracture. He recommended that the walls should be cut through on the lines of the cracks in the northeastern and southeastern corners and at the center of the eastern wall, and that the excavations should be filled with brickwork; so that in the event of any future movement taking place it should be distributed among the joints and not determined to one spot as in the practically monolithic concrete. He further recommended that, in order to set free any latent but hitherto undeveloped strains in the structure, cuttings should be made in the northern, western and southern walls, and filled in a similar manner to those at the cracks on the eastern side of the reservoir. The flooring on the line of fracture was to be removed and replaced with concrete, together with any of the underlying cabook foundation that might be found damaged. To protect the walls from the action of the sun, the reservoir was to be surrounded, up to the level of the cornice, by an earthen embankment; and above the cornice an additional parapet wall was to be built all round the reservoir, a space being left between the new parapet and the original roof parapet. As an additional precaution, the floor and walls of the reservoir were to be lined throughout with asphalt.

These recommendations were accepted by the government, and the work was begun in January, 1889. Observations were taken with a view to ascertain with certainty whether any measurable movement of the walls took place which could be fairly attributed to variations of temperature. The observations showed that minute movements did undoubtedly take place, and that these movements corresponded with the changes of temperature. On Feb. 19, therefore, it was decided to cover the arches with a layer of gravel about 4 ins. deep; and when this had been done the daily movement in question practically ceased, though intermittent movements were still observed both at the northeastern corner and other places. In consequence of the success attending the covering of the arches, it was determined to extend the embankment above the cornice so as to completely cover the walls, Fig. 3. The cuttings at the middle of the northern, western and southern walls were carried down to 2½ ft. below ground level (that is to say, 32½ ft. below top water level) and were refilled entirely with brickwork. On the lines of fracture at the northeastern and southeastern corners of the reservoir, and at the middle of the eastern wall, the walls were cut through to the foundation and refilled with concrete to a level 2½ ft. below the general ground level, or 32½ ft. below top water level. Above this level all the wall cuttings were refilled with brickwork. At the southeastern corner and at the middle of the eastern wall the fractures did not extend below the concrete. In the northeastern corner the crack extended below the wall into the underlying cabook. In the outer part of the foundation the crack in the cabook did not extend more than 2 to 3 ft. below the concrete. For a short distance under the inner portion the crack was traced to a depth of 13 ft. below the concrete, and under the floor it extended to an average depth of 7 ft. below the concrete, as far as the commencement of the upward curve of the southern footing, where it died out.

The cabook was taken out to a depth of 1 ft. below the crack and was replaced by concrete. The crack in the cabook was well defined and regular, though not of measurable width. Its direction was nearly vertical. There was no sign of squeezing or compression of the cabook, and the sides of the cutting, even in the deepest part under the wall at the northeastern corner, remained perfectly sound without timbering. This affords additional proof of the firmness and solidity of the foundations. By the end of March, 1889, the cuttings through the walls and foundations had been made and refilled to a height of 24 ft. below top water level. The embankment at the outside of the walls was at this time about 22 ft. below top water level. After this the filling of the wall cuttings was delayed until the embankment had been carried to a height of from 2 to 3 ft. above top water level all round the walls. This was done in order that the daily movement of the walls caused by variation of temperature should have ceased before the cuttings were filled up.

The asphalt was composed of the best Seyssel rock

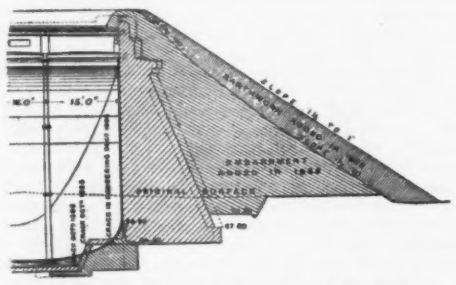


Fig. 3. Section Through South Wall.

asphalt, entirely free from grit, and was melted with a sufficient quantity of refined mineral bitumen to secure pliability in working. The asphalt was laid on the floor in two ½-in. layers, arranged to break joint. The surfaces of the walls were roughed and grooved, and the asphalt was plastered over them to a thickness varying from ⅝ to ¾ in. At both sides of each wall cutting an asphalt key was formed near the center of the wall, cutting off the joint between the concrete and the brickwork filling. The portions of the roof-arching which had been omitted to give light for working inside the reservoir were now completed, and the sumps and piping for draining the roof were laid. These repairs were completed by the end of September, 1889.

The filling of the reservoir was begun on Oct. 5, 1889. The reservoir was filled to top-water level by Nov. 4, 1889, and was allowed to remain full for several days. Excepting a very slight escape of water through one of the supply-valves, the work was found to be perfectly water-tight, and has remained so to the present time, November, 1893. The regular supply to the town from the service reservoir was begun on Nov. 9, 1889. After the reservoir had been tested, the waste-weir level was lowered to 1 ft. 1 in. below the original top-water level, in order to give ample margin between the surface of the water at the times of greatest overflow and the upper edge of the asphalt lining. The available capacity of the reservoir is now about 10,000,000 U. S. gallons, and the greatest depth of water 37 ft. 11 ins.

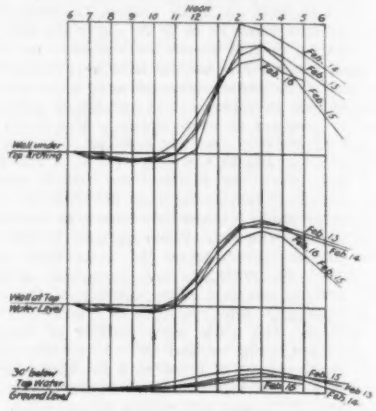


Fig. 4. Diagram of Wall Movements at Northeast Corner of Reservoir, Inside Angle of Wall.

When the reservoir was nearly full, two cracks appeared, one at the joint on the eastern side of the wall-cutting, near the southeastern corner, and the other in the northern wall, opposite the fourth row of columns counting from the east (about 60 ft. from the face of the eastern wall). These cracks have gradually developed, and at the present time, November, 1893, the former is 3-16 in. wide, and that in the northern wall fully ¼ in. wide, measured near the top of the wall. In December, 1892, the reservoir was emptied in order that the sediment which had accumulated on the floor and walls might be removed. Advantage was taken of this opportunity to examine the cracks, a small portion of the asphalt being temporarily removed for the purpose, and it was found that they both gradually diminished and died out a short distance above the curved footing. The asphalt lining prevents any leakage through these cracks, and they therefore do not affect the efficiency of the reservoir, which remains in regular use. During 1893, the stress on the tie-rods of the upper arching has been distributed by adding to their number, and additional earthwork is being laid on the embankment so as to give it a slope of 1½ to 1 throughout.

Turning to the causes of the failures described, it may be said at once that they could not have been caused by insufficient strength of the wall or foundations to resist forces due to gravity and water-pressure. The stress diagrams show that the lines of pressure in the walls are at safe distances from the faces; the load on the foundations did not exceed a maximum of 4,428 lbs. per sq. ft., at the outer edge of the wall (before the earthen embankment was formed), and no indications were given, by the levels carefully taken, of any yielding of the foundations. It remains to consider the effect of temperature. The fact that the variations in temperature to which the reservoir was exposed before the construction of the embankment did actually produce a marked effect, was clearly proved by the observations alluded to above. The method of taking these observations was as follows: A small cavity was made in the wall, and two brass plates were fixed, one on either side of the cavity, the edges of the plates being made parallel to each other and about 1 in. apart. A wedge was inserted between the plates, tapering 1-16 in. in 3 ins. Any difference in the penetration of the wedge showed a change in the distance between the plates of 1-48th part of that difference.

The daily oscillation of the tops of the walls (where the influence of temperature was greatest) at the places where they had been cut through, ranged from 0.005 to 0.01 in., according to the position of the cutting and the state of the weather. The diagrams, Fig. 4, show the course of the daily movements as observed at the southeastern corner on Feb. 18, 19 and 20, 1889, and at the northeastern corner on twelve days between Dec. 18, 1888, and Feb. 22, 1889. The most considerable daily movement was observed at the top of the wall at the northeastern corner of the reservoir. The gage plates were placed on either side of the line of the fracture which occurred in February,

1887. The movement became fully developed when the eastern wall had been completely separated from the northern one, by cutting through the concrete. It consisted, as shown on the diagram, of a widening of the aperture which attained a maximum of 1-40 to 1-50 in. between 2 p. m. and 4 p. m., returning towards evening to the position of the morning. This movement would be produced either by expansion and contraction of the walls, or by an outward and inward movement of the top of the eastern wall, due to the thrust caused by expansion and contraction of the roof. As, however, expansion of the walls would cause the aperture to close, and as, on the contrary, it widened as the temperature rose, it appeared probable that the thrust of the roof was the true cause. The roof was therefore covered with earth to a depth of 4 ins., and the protection thus afforded was sufficient to practically eliminate the movement in question. After this, the daily movements at the northeastern corner became about the same as those observed at the southeastern corner.

After the walls had been covered by the embankment, the daily movements ceased, but intermittent movements still occurred from time to time, and caused the cracks which appeared after the filling of the reservoir in November, 1889. The development of these cracks has been carefully observed, and seems to afford evidence of the action of a force, at or near the top of the wall, quite independent of the pressure of the water.

The cracks are, as already stated, widest near the top of the wall and disappear before they reach the curved footing at its base. The cracks have not opened continuously. On several occasions they have partially closed. The movement has not increased or decreased correspondingly with the varying pressure of the water.

Towards the end of November, 1892, when the reservoir had been emptied for the purpose of cleaning the floor, and when the pressure of the water was consequently nil, the crack in the northern wall increased in width by about 1-85 in., and that near the southeastern corner by about 1-24 in. After the refilling of the reservoir had been begun, and while the pressure of the water was constantly increasing, both the cracks began to close up again—that in the northern wall contracting back to its former width, and that near the southeastern corner narrowing by about 1-38 in. The closing movement did not cease till the surface of the water had risen to a height of 30 ft. above the floor, or more than three-quarters of its full depth. The lowest temperatures during periods of rain vary between 63° and 73° F., the ordinary shade temperature is 80° to 83°, and sun heat frequently exceeds 140° F., and sometimes rises to 150° F. The range of temperature inside the reservoir is small, probably never more than 10° (or between 72° and 82°), and the water enters the reservoir at a temperature varying between 80° and 82° F.

The original contract amount for the construction of the works was $156,000, the sum for ironwork, pipes and valves being $20,800, and for land $28,000, making a total for the work as originally designed of $205,200. The total amount actually spent up to the completion of the reservoir, including the cost of all repairs and alterations, but excluding staff expenses, was $263,200.*

Before the repairs of 1889 were begun, numerous tests were made by Mr. W. H. Stanger, F.C.S., to ascertain the comparative strength of different mixtures of asphalt and bitumen. The specimens tested were prepared with 5, 7½ and 10% of added bitumen. Tests were made to show the compressive, tensile and adhesive strength of the different mixtures. The analysis of the natural rock asphalt gave bituminous matter 14% and carbonate of lime 86%. The specific gravity of the asphalt was 2.301, and that of the mineral bitumen 1.235. The results of the various tests showed that asphalt would remain in position when used as a thin lining or coating on a vertical wall. It was therefore decided that the asphalt lining on the walls of the Maligakanda reservoir should be applied in the form of a coating or plastering, and run in a molten state, as at first proposed, between the face of the wall and a 9-in. retaining wall of concrete blocks. In practice it was found that the addition of even so little as 5% of bitumen made the asphalt too soft. The total quantity actually used amounted to about 3% of the quantity of asphalt. Some part of the added bitumen would evaporate while being stirred in the caldrons, and it is probable that the finished asphalt does not on an average contain much more than 2% of this substance. Specimens cut while the work was in progress were found to be exceedingly pliable and could be bent to a radius of 1 or 2 ins., if carefully handled.

In order to ascertain to what extent cracks could open behind the asphalt without tearing it, a layer of asphalt, ¾ in. thick, was spread so as to cover the faces of two concrete blocks. The blocks were then gradually forced apart with wedges to the extent of about ¾-in., and were left in that position for more than a month. The asphalt showed no sign of tearing or of slipping on the concrete surfaces.

Some slight difficulty was experienced owing to the rainwater percolating through cracks in the roof arches and getting behind the asphalt lining under the lower girder-beds. Wherever this occurred, the adhesion of the asphalt to the face of the wall was destroyed, and a bulge or blister was formed which, if not checked, gradually extended down the face of the wall, the width affected being usually above 2 to 4 ft. This was remedied by drilling holes in the wall immediately below each girder-bed, so as to drain away all rainwater which might percolate there and prevent it from getting behind the asphalt. Wherever the asphalt was blistered, it was cut away over the area affected. The asphalt thus removed could not be replaced by plastering it on the wall in the ordinary manner, owing to the dampness of the surface; it was therefore necessary to use asphalt plates attached to the wall by mortar.

* These figures of cost are on the assumption that the average value of the rupee from 1882 to 1889, the period of construction and repairs, was 40 cts., against the normal value of about 48 cts. The value of the Indian rupee is now very low.—Ed.

CORROSION OF IRON PIPES BY ELECTRIC RAILWAY CURRENTS.

At the meeting of the Western Society of Engineers, on July 11, a paper with the above title was read by Prof. D. C. Jackson, M. Inst. Elec. E., of the University of Wisconsin. The paper described an extensive series of laboratory experiments carried out at the University by two students to determine under what conditions electrolysis of iron pipes actually takes place.

In the first place the author took up the claim that the so-called electrolytic action is actually nothing but ordinary corrosion, caused by ammonia, saltpeter, leaky gas mains, etc. The author held that the rate at which corrosion has occurred and the fact that corrosion occurs at points where an electric current is known to leave the pipes is conclusive proof of electric action.

There are three ways in which the electric current might cause corrosion. (1) By actual electrolysis of the iron, (2) by electrolysis of chemical compounds in the soil, and (3) by electrolysis of water in the soil, the nascent oxygen attacking the iron. An examination of the corroded pipes, however, shows that the action is undoubtedly due to the electrolysis of substances held in solution in the water of the soils, with a resulting secondary chemical action on the pipes.

Nearly all street soils contain more or less ammonia, potash and soda salts. Six small electrolytic cells were connected in series under 100 volts pressure. Each cell contained clear glass sand, moistened with water containing a nitrate or a chloride of the above chemicals. The anodes of the chloride cells showed the greatest losses and the nitrate cells the smallest losses. The results of the experiment are considered to prove the correctness of the theory of corrosion, which has been finally worked out and which is as follows:

In an electrolytic cell with iron electrodes and a soluble salt or salts of the metals of the alkalies or alkaline earths in solution in the electrolyte, the salt is electrolyzed by the current, the acid radical attacks the anode, forming an iron salt, while the alkaline metal forms with water a hydroxide, at the cathode, liberating hydrogen there. Finally, the meeting by diffusion of these two products precipitates ferrous hydroxide, Fe (OH). As the amount of electrolysis varies with the strength of the current, a comparatively high current will liberate the acid radical more rapidly than it can combine with the iron, the critical point depending upon the affinity of the acid for iron. When this excess is present, the radical forms an acid by combining with water and at the same time liberates oxygen. Neither the acid nor the oxygen can combine with the anode because that is already engaged in the formation of an iron salt with the acid radical, and hence the gas escapes into the air. If the acid is formed in sufficient quantity, it diffuses through the electrolyte, meets the alkaline hydroxide and forms the original salt and water. In the case of chlorides, the nascent chlorine liberated at the anode forms with it a chloride of iron, and if the current is strong enough to form an excess of chlorine it will be dissolved in the water and may, under the influence of light and heat, form an acid and liberate oxygen; or, if enough heat is generated, free chlorine will be given off, as is shown by experiment.

All conditions of these laboratory experiments are practically paralleled in the earth, and hence it is safe to say that similar chemical reactions must go on there. Although the composition of street soils is more complex than the electrolytes of these experiments, they contain the same soluble salts, and as these are diffused through the moist earth they must lend themselves to exactly similar electrolytic influences and chemical changes. In fact, where street soils were used in the experiments as the electrolytes of cells which were placed in series with cells containing known quantities of simple and mixed soluble salts, the losses of the anodes were entirely comparable. It is consequently seen that only such measures as will stop the electrolytic action on salts in solution in the soil can be relied upon to stop the corrosion of iron pipes.

Tests were made to determine what minimum voltage was required to cause electrolysis, and are described by the author as follows:

The iron electrodes were inserted in clean glass sand 1.5 cm. apart, and had about 20 sq. cm. exposed area. In the first cell a 1% solution of nitrate of soda was used with a voltage of 1.2. As before, the hydroxide layer was formed. The electrolytic action was plain without any other tests. In the following cells, the existence of action was shown by chemical tests for the iron salt and the alkaline hydroxide. In the second experiment, a ½% solution of nitrate of soda was used with 5 volts. The action was at once apparent:

Cell 3.	Pressure	.25 volts.	Action in	3 min.
" 4.	"	.125 "	"	5 "
" 5.	"	.125 " 1-6% solu.	"	5 "
" 6.	"	.05 " "	"	40 "
" 7.	"	.013 " "	"	50 "
" 8.	"	.005 " "	"	1 hr.
" 9.	"	.001 " "	"	1 hr.
" 10.	"	.01 " "	Act'n in	4 hrs. 45 min

In cell 10 the electrodes were 20 mm. apart and were 40 mm. by 68 mm. in exposed surface. The electrolyte was street soil.

A surprisingly low voltage produced an appreciable electrolysis in the sand cells. The pressure on cell No. 10 might undoubtedly have been reduced to a millivolt without stopping the corrosion, but the resistance of the soil was so high and the percentage of soluble salts so low, that the time necessary to produce action would have been considerable. A milliammeter showed a barely perceptible reading in the case of the experiments in which very low pressure was used. The observations plainly show that a mere directive force is necessary to produce electrolysis, and the corrosion is simply a question of current.

It is impossible to give in a reasonable space even a summary of the great number of experiments which were made, but the following conclusions are directly drawn from them:

1. In no case is the action due to the electrolysis of water. Where oxygen is liberated at the anode, it does not attack the iron.

2. Only a mere directive force in the nature of a pressure will cause electrolysis.

3. The actual corrosion is therefore only dependent upon the actual current which flows, and is as much dependent upon the resistance of the soil as upon the pressure tending to cause the current.

4. Only a minute quantity of soluble salt is sufficient to start the action, and it will then continue as long as a current flows.

5. The gravity of a corrosion of a pipe depends on the amount of current flowing from a given area and the nature of the salts present in the soil, the order of the activity of the salts being (1) chlorides, (2) nitrates, (3) sulphates.

Concerning the effect of frequent reversals of the current, suggested by Mr. I. H. Farnham, as a remedy for corrosion (Eng. News, May 3, 1894), the author found that the reversals would have to occur as often as 15 seconds, which would make it wholly impracticable. The practical method of preventing corrosion, according to the author, is by providing a proper system of return circuits. The use of the alternating current, or a double trolley system, would be a complete preventive, but alternating motors for street railway work are not yet an assured success. Connecting the pipes and rails with heavy cables at points where the former are positive to the latter proves the most complete method of prevention. The conductivity of the track circuit must be properly reinforced by feeders so that an undue drop is not experienced in the return conductors. These track feeders should always be insulated and put on the lines exactly as are overhead feeders, in order to save them from corrosion. The connection of pipes and rails has been practically carried out in Milwaukee, Wis., at a cost of about $8,000, and has apparently done away with the trouble, and has at the same time decreased the resistance of the return circuit. In the Milwaukee system there are about 125 miles of track and over 200 cars in daily operation. The track circuit was originally put down in excellent shape. In the Madison system present indications show that one connection between rails and pipe systems opposite the power house, costing, all told, about $15, would prevent any serious action. The author concludes as follows:

Investigations have shown that when the negative pole or the generator is connected with the trolley, the pipes are positive to the rails over an extended outlying district, and corrosion goes on over a large area, while with the reverse arrangement the dangerous area is concentrated about the power station. The latter method of connection allows the difficulty to be most easily handled, and after the district within which the pipes are positive to the rails has been accurately determined by proper voltmeter tests, frequent connections of pipes and rails should be made within its limits. This can usually be done at a comparatively small cost, the interest on which may be annually saved by the decrease of lost power if the connections are properly placed. The boundaries of this district should be rechecked from time to time, and the corresponding changes in connections should be made, if the tests show that they are necessary. The outlines of the danger district are likely to vary with the growth of the system, and even change slightly with the seasons, and the connecting wires may be eaten away, so that vigilance is here as everywhere the price of safety, but safety may be absolutely secured in most cases.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago—Existing Roads.

WASHINGTON & CHESAPEAKE BEACH.—A press despatch from Upper Marlboro, Md., states as follows: Work on the Washington & Chesapeake Beach R. R. has started again after a suspension of several weeks. Carloads of lumber for the new station near Marlboro have arrived and are now being unloaded. C. R. Kohl & Brother, Germantown, Pa., have the contract for the work. The building will be of frame, 44 x 25 ft., and will cost about $3,000. An artesian well will be sunk near the station. Barges are arriving over the Patuxent River daily with material for the construction of the railway bridge over the river. It is also said that the road has been able to place its construction bonds. If this is so, there seems to be nothing to prevent the completion of the road.

Projects and Surveys.

BEECH CREEK, ALTOONA & SOUTHWESTERN. Incorporated in Pennsylvania to build a railway from Walkers, Cambria county, thence southwesterly by way of Altoona and Hollidaysburg, to Orehill, Blair county, to connect with the Altoona short line railway, a distance of 40 miles; capital stock, $1,000,000; Pres., Samuel P. Langdon, Philadelphia; directors, S. R. Fires, S. J. Westley, William Loudon, Warren S. Lee, William J. Heinsling, John Loudon, Altoona; William E. Stein, Bryn Mawr; William T. Forsythe, Avondale; George W. Dickey, Houtzdale.

BLACK RIVER.—Geo. Ayer, Ch. Engr., Perkinsville, Vt., writes us that the contracts for building this railway will probably be awarded Sept. 3. The line is projected from Bellows Falls to Springfield, Vt., a distance of 11 miles.

BLUE MOUNTAINS—This company proposes to build a railway along the route of the old South Mountain project, from Harrisburg to Hamburg, Pa., with an extension from Straustown to Reading. Surveys were commenced by Robert Frazer, at Reading, Pa., July 30, on the line to Harrisburg. The following Philadelphia business men are reported as interested in the new road: Clinton Rohrer, Pres. Farmers & Drovers' Stock Co., Chestnut Hill; Simon R. Snyder, Pres. Snyder, Harris & Bassett Co.; Kensil Wills, of Kensil Wills & Brother, real estate; Frank Crenton and W. E. Camp, directors of the Millward Cracker Co. W. C. Mayne, Philadelphia, is attorney for the company, and James Clark will be superintendent of construction.

BRADY'S BEND & BUTLER.—The organization of the company formed by J. D. Gillette, 2 Wall St., New York, to build this railway and to develop the coal lands secured by his purchase of the property of the Brady Iron Co., is going ahead rapidly, according to the "Railroad Gazette. The President of the new company will be C. O. Billings, Boston, who has resigned his office as president of the Globe National Bank of that city to give his time to promoting the interests of the new company. The railway will not be more than 12 miles long, starting from Brady's Bend on the Allegheny River opposite East Brady, and extending northwest to Butler, Pa. The railway will be built by the Brady's Bend & Butler R. R. Co., and the other operations of the company will be carried on by a corporation called the Brady's Bend Phoenix Co., Mr. Billings being president of both companies.

CANADIAN SUBSIDIES.—Additional railway subsidies are reported to have been voted as follows: For a railway from Newport or Windsor to Truro, N. S., and to Eastville, 90 miles, $300,000; Nipissing & James Bay, for 25 miles, from near North Bay Station on the Canadian Pacific towards James Bay, Ont., $217,000; Lotbiniere & Megantic, Que., $48,000; Drummond County, from St. Leonard northerly to Chaudiere Junction, Que., $96,000; for a railway from Lime Ridge, Que., into the county of Megantic, $160,000; Strathroy & Western Counties, from St. Thomas towards Forest Station on the Grand Trunk, $80,000; Parry Sound Colonization, for 20 miles from Parry Sound, $64,000; Manitoulin & North Shore, from Little Current to Nelson on the Algoma branch of the Canadian Pacific, $32,000; United Counties, for 32 miles from Iberville to Sorel, $102,400; Joliette & St. Jean de Matha for 12 miles from St. Jean de Matha to St. Emelie de l'Energie, $38,400; Great Northern, for 22 miles, $70,400; Quebec & Lake St. John, for 14 miles of the Chicoutimi branch, $44,800; Pontiac & Ottawa, for 23 miles to Ferguson's Point, $73,000; Ottawa & Gatineau Valley, for 20 miles from the eastern end of the 62 miles already subsidized towards Desert, $64,000; Canada Eastern, for 6 miles from the town of Chatham to Black Brook and to the village of Nelson, $32,000; for a railway from Cross Creek Station on the Canada Eastern to Stanley village, $19,200; Restigouche & Victoria, for 20 miles towards Grand Falls, $64,000; Central Ry., for 15 miles from Chipman Station to the Newcastle coal fields, $48,000; Tobique Valley, for 15 miles from the present terminus at Plaister Rock easterly, $48,000; towards the restoration or renewal of the railway bridge on the Southeastern Railway over the Yamaska River at Yamaska, $50,000; Boston & Nova Scotia Coal & Railway Co., for 10¼ miles to Broadcove; also for 25 miles from the Cape Breton Ry., near Orangedale, towards Broadcove, $113,600; for a railway from Port Hawkesbury towards Cheticamp, 25 miles, $80,000; Manitoba Northwestern Ry., for 100 miles towards Prince Albert, $320,000; for a road from the junction of the Elk and Kootenay River to Coal Creek, 34 miles, $108,800; for a railway from Abbottsford Station on the Moosomin Branch of the Canadian Pacific to the town of Chilliwack, B. C., 21 miles, $67,200; Nicola Valley, for 28 miles towards Nicola Lake, B. C., $89,600; Nakusp & Slocan, for 38 miles from the town of Nakusp, B. C., $121,600; Pontiac & Kingston, for 22 miles from Portage du Fort to Upper Thorne Centre, Que., $70,400; New Glasgow Iron, Coal & Ry., for 5 miles from Sunnybrae to Kerrogare, N. S., $16,000; South Shore, for 35 miles from Yarmouth towards Shelburne, N. S., $112,000; Cape Breton Ry. extension, for 30 miles from Port Hawkesbury to St. Peter's, N. S., $96,000; for a railway from a point on the Intercolonial Ry., between Norton and Sussex stations towards Havelock, N. B., 20 miles, $64,000; for railway from St. John's to Barnesville, N. B., 10 miles, $32,000; for a railway from Cape de la Magdeleine, Que., to connect with the Piles Branch of the Canadian Pacific, 3 miles, $9,600; Canada Eastern, for an extension of 1 mile, $3,200; Great Northern, for 30 miles from a point on the Canadian Pacific near Maskinonge or Louisville, Que., towards the River Mattawa, $96,000; Lindsay, Bobcaygeon & Pontypool, for 32 miles from Bobcaygeon to Pontypool, Ont., $102,400.

CAPE COD SOUTH SIDE.—F. W. Parsons, Pres., Wianno, Mass., writes us that surveys are now being made for this railway, projected from North Falmouth to Centerville, Mass., a distance of about 20 miles. If the line is built it will be leased by the New York, New Haven & Hartford, with which it will connect at each terminus. W. H. Healy is the chief engineer.

COAST RY. OF NOVA SCOTIA.—The contract for building and equipping this road has been awarded to the Nova Scotia Development Co., Yarmouth, N. S. The road will be 90 miles in length, extending from Yarmouth to Lockeport, of which the first 25 miles have been located. It is intended to have the line completed to Tusket, 10 miles, by Oct. 1. A. H. Chadbourne, 29 Broadway, New York, is superintendent of construction.

SWIFT RIVER.—We are informed that this railway will be built and operated independent of the Portland & Rumford Falls, although practically an extension of that road. The line will begin at Rumford Falls, Me., cross the Androscoggin below the Knapp fall, and follow up the west bank of Swift River, probably crossing it several times. About 20 miles of road will be built at first. It will be standard gage, and operated as a lumber railway for the present. The principal stockholders are the Androscoggin Water Power Co., the Berlin Mills Co., the Otis Pulp Co., and the Umbagog Pulp Co. Surveys were commenced at Rumford Falls last month by R. B. Stratton, Ch. Engr., and the construction is expected to be commenced at an early date.

Northwest—Existing Roads.

CHICAGO, MILWAUKEE & ST. PAUL.—Press reports state that McIntosh Bros., Milwaukee, have contracted to build an extension of this railway from Minocqua, Wis., 20 miles northeast through the lumber tracts of Oneida county; the road to be completed Nov. 1.

DAKOTA, WYOMING & MISSOURI RIVER.—Efforts are being made to resume work on this road this summer. Pres., W. T. Coad, Rapid City, S. Dak.

HOLMES & SON'S LOGGING RY.—Will H. Rights, Pembine, Wis., is in charge of surveys that are being made for an extension of this railway, which is intended to reach newly discovered granite quarries, and open up a large lumber region at the headwaters of the Pike River. A connection will be made with the Minneapolis, St. Paul & Sault Ste. Marie one mile west of Pembine, Wis., and this, with the present connection with the Milwaukee & Northern, will enable the company to make large shipments of granite and hardwood timber. The company is now putting 1,500,000 ft. of pine into the Menominee River each week.

Southwest—Existing Roads.

GEORGETOWN & GRANGER.—M. P. Kelley has submitted a proposition to the citizens of Georgetown, Tex., for completing this railway, which is already graded for a distance of 15 miles, and extending the line to Trinity, Tex. The citizens of Georgetown have already spent more than $40,000 on the work, according to reports. Dr. J. C. Anderson, W. S. Leake and M. B. Lockett were appointed a committee to present the proposition to the stockholders not present at the meeting.

PECOS VALLEY.—Work on the extension from Eddy to Roswell, N. Mex., is reported as progressing rapidly. The rails are laid to the second crossing of the Pecos River, a short distance below Lake McMillan. Pres., J. J. Hagerman, Colorado Springs, Colo.

SAN ANTONIO & GULF SHORE.—The construction of this road was noted last week. A later press report from San Antonio, Tex., states that the construction force was doubled Aug. 2 and the subcontracts let for the construction of 15 more miles of roadbed. Ex-Governor Ireland, the general attorney of the company, has stated that all reports that the road would not be built are unfounded, as the money for the work is in hand and the line will be constructed as fast as men can do it. William Davis, Pres., is in the East to contract for rolling stock for the road.

WEATHERFORD, MINERAL WELLS & NORTHWESTERN.—It is stated that this road will soon be extended northwest from Weatherford, Tex. Pres., L. M. Fouts, Weatherford, Tex.

Projects and Surveys.

KANSAS, OKLAHOMA CENTRAL & SOUTHWESTERN.—A press report from Guthrie, Okla., states that ex-Secy. Robert Martin, has returned from London where he secured the money necessary to construct this railway, which is projected from Coffeyville, Kan., southwesterly across Oklahoma to Vernon, Tex., and on to Albuquerque, N. Mex. Pres., Gilbert Martin, Guthrie, Okla.; Vice-Pres., Geo. Gardenhire, Stillwater, Okla.; Secy., T. C. Frazier, Coffeyville, Kan.; attorney, S. V. Powter.

Rocky Mt. & Pacific—Existing Roads.

MONTANA MIDLAND.—R. A. Harlow, Helena, Mont., the chief projector of this road, is reported as stating that he has made arrangements in the East for resuming work on this road beyond the Missouri River, within a few weeks, and that he hopes to complete most of the line to the mineral lands in Southeastern Montana, to which the railway is projected, before the end of the year. The line is now graded for about 20 miles from Helena east to Canon Ferry at the Missouri River, and also from Whitehall. The coal fields to which the railway is to be built are on the Upper Ruby River, about 80 miles southeast of Helena.

MONTEREY & FRESNO.—L. W. Jones, Pres., Monterey, Cal., is reported as having recently made the following statement concerning the work on this road, which was commenced July 4: Our force of men and teams is extended over 10 miles of road, and 2½ miles are graded and ready for the ties and rails. The contractors have been crippled by the strike, as much of their grading apparatus has been tied up in the north. Thirty mule teams were shipped to Monterey to-day, and work will progress more rapidly from now on. Heretofore we have had 60 teams and about 120 men at work. We have the advantage of good feeling among the farmers about Monterey and along the road to Salinas. They are turning out with their teams and offerring their assistance for almost nothing. Times have not been so lively in old Monterey in 10 years. A house is not to be rented there now at any cost. Work will be commenced this week on the construction of the 1,000-ft. pile pier, which is to extend out into the harbor from Monterey. The grading of the road is being done by the contracting firm of McLean & Earles. Mr. Earles, who is a well-known railway contractor of Seattle, and the owner of extensive timber interests along the coast, says that the grading will be completed to Salinas by Sept. 1.

SAN PETE VALLEY.—The contract for grading the 8-mile extension, noted last week, has been awarded to Henry Beal, Ephraim, Utah, and the work is to be completed by Sept. 15. The contract price for the work, including all necessary side tracks, is said to be $10,000 per mile.

STREET AND ELECTRIC RAILWAYS.

MARLBORO, MASS. The aldermen have granted a franchise for an electric railway between this city and Hudson.

WEYMOUTH, MASS.—Press reports state that steps are being taken to organize a company to construct an electric railway from East Weymouth to Braintree, a distance of about four miles; estimated cost, $10,000 a mile. John Kelley, Braintree, and J. H. Flint, Weymouth, are interested.

COHOES, N. Y.—The Cohoes City Ry. Co. has been incorporated to build an electric railway about five miles long; capital stock, $50,000; directors, Urban Weldon, Murray Hubbard, E. W. Lansing, and others.

LOCKPORT, N. Y.—Q. G. T. Parker has petitioned the council for a franchise for a street railway to be 10 to 15 miles long. The franchise granted to the Lock City Electric Ry. Co. has become void.

RHINEBECK, N. Y.—It is reported that steps are being taken to construct an electric railway two or three miles in length, for which a charter and right of way has been granted.

LOCK HAVEN, PA.—The Lock Haven Electric St. Ry. Co. is reported as receiving bids for constructing a brick power house and car barn 51 x 110 ft.

YONKERS, N. Y.—The council has granted a franchise to the North & South Electric R. R. Co., recently noted as incorporated.

FREEHOLD, N. J.—The Monmouth Electric Traction Co. has been incorporated by W. W. Conover, C. B. Parsons, James Enright and others, to build an electric railway from Red Bank to Lang Branch; capital stock, $300,000.

MILLVILLE, N. J.—The Millville Traction Co. has been incorporated with a capital stock of $400,000, to build an electric railway from this place to Vineland.

SYRACUSE, N. Y.—Surveys are being made for an extension of the Syracuse St. R. R. to Solvay, and the construction will soon be commenced, according to reports.

POTTSVILLE, PA.—The Pottsville & Schuylkill Valley Traction Co. has been incorporated with a capital stock of $400,000; Pres., J. I. Aiken, Philadelphia; Secy. and Treas., J. F. Sadler, Carlisle; S. B. Edwards, Pottsville.

READING, PA.—The committee has voted in favor of granting a franchise to the Birdsboro St. Ry. Co. for an electric railway from this city to Womelsdorf. A bridge will have to be built over the Schuylkill River.

WASHINGTON, D. C.—The president has signed the Metropolitan Ry. bill which gives the road authority to change its motive power, purchase new equipment and to make extensions.

RANDALLSTOWN, MD.—The Randallstown, Granite & Harrisonville Rapid Transit Co. has been reorganized and is reported about to build an electric railway from Pikesville to this place; Pres., H. J. Hebb, Randallstown; Secy. and Treas., J. G. Floyd, Baltimore.

CHILLICOTHE, O.—The plant of the Electric St. Ry. & Lighting Co., which is appraised at $30,000, will be sold at auction Sept. 3.

COLUMBUS, O.—J. H. Anderson, C. B. Cowan, D. C. Jones, T. J. Keating, G. L. Converse and others have been granted a franchise for an electric railway from this city to the Licking reservoir.

ROCKPORT, O.—The Minch Transit Co. has been incorporated, with a capital stock of $150,000, by P. J. Minch, J. B. Guthrie, William Gerlach.

UPPER SANDUSKY, O.—The Sandusky Valley Electric R. R. Co. has been incorporated to construct a railway between Marion and Port Clinton; capital stock, $10,000; incorporators, J. Q. Wirick, R. R. Dumm, F. E. Dumm, G. H. Roppold, Thos. Carroll.

PARIS, IND.—It is stated that Frank Fairbanks, Terre Haute, is arranging for the construction of an electric railway in this city.

CHICAGO, ILL.—The Englewood & Chicago Electric St. Ry. Co. expects to have its main line to Morgan Park completed in three months. This is one branch of a proposed system to be 45 miles long. It is stated that the power house with equipments will cost $100,000. The capital stock of the company is $1,000,000 and the bond issue is $2,500,000. Pres., W. H. Comstock; Secy., F. E. Elder.

WARSAW, ILL.—Press reports state that a movement has been inaugurated by J. C. Hubinger, proprietor of the Keokuk Electric St. Ry., to extend the lines to this city and also to Carthage and Nauvoo, Ill., crossing the Mississippi by means of a high bridge at Keokuk. Local capitalists will make an effort to have the bridge built here, as a charter has been secured and better approaches are provided on both sides of the river.

FORT HOWARD, WIS.—A franchise for a street railway has been granted to D. McCartney.

SEDALIA, MO.—It is stated that surveys will soon be made by Charles Zoll for an electric railway 40 miles long, the work requiring two bridges. F. E. Hoffman is interested.

GREENVILLE, TEX.—The city has granted a franchise for an electric street railway.

SAN FRANCISCO, CAL.—The Sutro R. R. Co. has been incorporated to construct a street railway five miles in length; capital stock, $400,000; incorporators, Adolph Sutro, O. D. Baldwin, J. H. Moore, T. J. Glynn, O. F. Van Rhein.

HAMILTON, ONT.—The Hamilton & Dundas Ry. Co. has voted to change the motive power of the road to electricity. Pres., B. B. Osler; Secy. and Treas., W. S. McBrayne.

ELEVATED RAILWAYS.

BOSTON, MASS.—The incorporators of the Meigs Elevated Ry. Co. have organized the Boston Elevated Ry. Co. Pres., Gen. C. A. Whittier, New York; Vice-Pres., G. H. Towle, Boston; Treas., G. J. Carney, Lowell; Clk. of the Corporation, F. C. Patch; Gen.

Counsel, Willard Howland, Chelsea; Ch. Engr., J. V. Meigs, Lowell; Consult. Engr., Gen. Herman Haupt; directors, T. W. Hyde, Bath, Me.; T. W. Myers, New York; J. H. O'Neil, Boston.

CHICAGO, ILL.—The Chicago & Suburban Electric Elevated Ry. Co., lately incorporated by J. M. Hannah, Albert Wahl, F. W. Wolf, and others, is reported about to petition the council for a franchise to construct an electric elevated railway.

HIGHWAYS.

KENTUCKY.—The good roads committee of Warren county is discussing the question of a county tax for road improvements. It is estimated that $13,820 will be sufficient to commence the work.

INDIANA.—Bids will probably be asked soon for constructing about 11 miles of roads in Grant county. S. P. Barley, Marion, is the county engineer. Contracts for building roads in this county have recently been awarded to David D. Studebaker, Bluffton, Ind., and Geo. Todd, Herbst, Ind., the other bidders being Busk & Keeley, Peru; David Overman, Marion; D. P. Drook, Mier; Barley & McKiney, Marion; Madiln & Neal, Herbst; Phillips & Eckroads, Hanfield; Calvin Miller, Roseburg; Jacob Druckemiller, Roseburg; Joshua Strange, Arcana; Hawkens & Brinker, Marion.

MICHIGAN.—The supervisors of Marquette county have voted to advertise for bids for constructing a road four miles long. G. P. Cummings, Marquette, has been engaged to make surveys.

WYOMING.—It is reported that surveys are being made for a road from Sheridan to the Big Horn basin, Sheridan county,

OREGON.—The question of constructing a road from Salem, Marion county, to Scio, Linn county, by subscription is being discussed.

CALIFORNIA.—Bids are asked until Aug. 21 for constructing a road six miles long in Humboldt county. O. D. Stern, Clk. Bd. Supervisors, Fortuna.

BRIDGES AND TUNNELS.

PHILADELPHIA, PA.—Jas. H. Windrim, Dir. Pub. Wks., informs us that the following contracts were awarded July 30: Bridge over Schuylkill River at the falls, to Filbert & Porter, Girard Bldg., at $248,500; time, 5 mos.; Torresdale Ave. bridge over Pennypack Creek, Phoenix Bridge Co., $43,056; time, 4 mos.; Wyoming Ave. viaduct over Frankford or Tacony Creek and Fisher's Lane, McHale & O'Connor, 14 South Broad St., $70,000; time, 6 mos.

WILLIAMSPORT, MD.—T. A. Brown, Hagerstown, is preparing articles incorporating the Potomac Bridge Co., which proposes to construct a $40,000 stone bridge across the Potomac River at this place, according to press reports.

AUGUSTA, GA.—Grant Wilkins, Atlanta, has been awarded the contract for building a steel viaduct over the Tiger River near Moores for the Port Royal & Western Carolina R. R. The viaduct will be 90 ft. high and 600 ft. long, and will cost about $18,000.

HAMILTON, O.—Bids are asked until Aug. 20 for the purchase of $100,000 in Butler county bridge bonds. Frank X. Duerr, Audr.——Of 18 bids received for the superstructure of the Gregory Creek bridge only the following did not exceed the estimate of $4,500: Nelson & Buchannan, $4,500; Toledo Bridge Co., $4,480 and $4,375; Hamilton Construction & Tool Co., $4,495.

SIOUX CITY, IA.—Bids are asked until Aug. 11 for constructing a combination wood and iron railway bridge and pile bridge approaches across the Floyd River at Fairmount Ave.; also for a pile bridge at same place. Sioux City Traction Co., 510 United Bank Bldg.

BUCHANAN, MICH.—An election was held Aug. 2 to vote on a proposition to issue $14,000 in bonds to build a bridge at this place.

MILWAUKEE, WIS.—The park board has asked for $40,000 with which to build two iron bridges in Lake park.

WEST DULUTH, MINN.—Plans have been completed for a bridge 700 ft. long and 66 ft. wide on the Grand Ave. extension.

LEXINGTON, MO.—The president has signed the bill authorizing the Lexington Bridge & Terminal Co. to construct its proposed bridge, for which plans are being prepared. W. F. Kerdoiff, Secy.

LITTLE ROCK, ARK.—The King's River & Osage Bridge Co. was incorporated Aug. 3 to construct highway bridges across King's River and Osage at points between Berryville and Eureka Springs; capital stock, $111,000; Pres., Chas. E. Davis; Treas., M. O. Hines; Secy., J. D. Jordan.

LEXINGTON, OKLA.—The senate has passed a bill authorizing the Lexington Bridge Co. to construct a bridge across the Canadian River between this city and Purcell, Ind. T.

WATER WORKS.

HALLOWELL, ME.—There is talk of works which will afford better fire protection than the present works.

BARRE, MASS.—Jas. F. Davis writes us that about half of the stock of the Barre Water Co. has been subscribed and that some preliminary surveys have been made by Chas. Allen, of Worcester, but that no other steps have been taken.

SOUTH DEERFIELD, MASS.—The water company is taking steps to secure works estimated to cost $12,000 or $13,000; supply from a brook; about 1½ miles of pipe will be required. P. D. Bridges is interested.

NEW HARTFORD, CONN.—We are informed that John T. Langford, Boston, has a large force at work on the new works.

WILLIMANTIC, CONN.—There is talk of putting in a steam engine at the pumping station or building another reservoir.

EDWARDS, N. Y.—The contract for constructing works has been awarded to A. B. Shannon, Watertown, at $3,650, and the contract for a wooden tank and tower has been sublet to Wm. Grout, Edwards, at $1,000. John Morrell, Mohawk, bid $4,300 for the entire work, and Otto J. Spencer, Union Springs, $4,000. The committee is thinking of purchasing a steel stand-pipe instead of the wooden tank. Dr. D. M. Taylor, Chn.

KINGSTON, N. Y.—The Kingston Water Co. has contracted for a supply from Cooper's Lake.

LE ROY, N. Y.—The citizens are discussing the question of works.

MORRISVILLE, N. Y.—A. M. Holmes and Dr. H. P. Mead are among the commissioners appointed to secure works.

NEW HARTFORD, N. Y.—Contracts have been awarded as follows: Pipelaying, Marmaduke Clark, Utica; pipe, Utica Pipe Foundry; laying pipe between reservoirs, Edward Martin, Utica; reservoirs, John McLaughlin, New Hartford. Engr., Prof. A. M. Scupture, New Hartford.

YONKERS, N. Y.—The commissioners have voted to extend the mains in several streets in the suburbs and to ask the council to issue $50,000 in bonds.

WESTWOOD, N. J.—C. S. De Baun has been granted a franchise.

WILDWOOD, N. J.—It is stated that works will be put in as soon as the new artesian well is sunk.

BRYN MAWR, PA.—The Bryn Mawr Water Co., in conjunction with the American Pipe Line Co., which has charge of the construction, proposes a line of suburban water works which is to extend from Rosemont to Bala and Overbrook and eventually to Oak Lane and Ashbourne, according to Philadelphia papers. About 17 miles of pipe have been laid, one 500,000-gallon stand-pipe erected and one artesian well sunk, and the work will require 18 miles more of mains, another stand-pipe and other wells.

CHRISTIANA, PA.—The Christiana Gravity Water Co. has been incorporated with a capital stock of $10,000.

FACTORYVILLE, PA.—The contract for laying the pipe for the new works has been awarded to A. H. Coons & Son, at about $20,000, according to reports.

HASTINGS, PA.—B. A. Nevling, Clk., writes us that the borough will probably put in a combined water-works and electric light plant in the near future.

PHILADELPHIA, PA.—I. H. Hathaway & Co., Girard Bldg., have been awarded contracts for erecting two pumping stations in Fairmount Park; buildings to be one story, 136 × 81.4 ft. and 180.6 × 81.4 ft., and the work will cost about $147,000, according to reports.

SINKING SPRING, PA.—It is stated that gravity works will be put in; supply from mountain springs; estimated cost, $10,000; S. B. Keppel and Dr. J. S. Herbein are interested.

ABERDEEN, MD.—Bids are asked until Aug. 15 for constructing works, including a 500,000-gallon reservoir, as stated in our advertising columns. Engr., C. M. Johnson, Baltimore. J. A. Swingley, Secy.

ANNAPOLIS, MD.—The Annapolis Water Co. has awarded contracts as follows: Pipe, Chattanooga Foundry & Pipe Co.; valves, Rensselaer Valve Mfg. Co.; pipelaying, John Johnson and R. G. Chaney. The itemized bids were published last week. Engrs., Jas. H. Harlow & Co., Pittsburg, Pa.

WINCHESTER, MD.—The question of works was voted upon Aug. 6.

GRAFTON, W. VA.—The city has sold $40,000 of water bonds.

MOUNDSVILLE, W. VA.—The contract for works has been awarded to Chas. Raper, Bellaire, O.; supply from wells.

AMERICUS, GA.—The council has contracted with the Frictionless Metal Co., Southern Agts., for a Pohle air lift pump, having a capacity of 15,000 to 20,000 gallons per hour, to use in the deep wells connected with the works. Cy. Engr. and W. W. Supt., G. M. Eldridge.

KEY WEST, FLA.—Press reports state that D. Lamar, New York, has been awarded the contract for constructing works at $95,500, of which $10,000 will be spent in sinking an artesian well.

TITUSVILLE, FLA.—The question of works is being again discussed.

ALEXANDRIA, LA.—It is expected that an election will soon be held to vote on a tax for works and electric lights.

CINCINNATI, O.—The residents of Oakley have petitioned that the mains be extended to that place, a distance of 10,000 ft., before the proposed paving of Madisonville Ave.

ST. BERNARD, O.—The Laidlaw-Dunn-Gordon Co. will furnish the pumps and the I. & E. Greenwald Co. the engines for the new works, both of Cincinnati.

SPRINGFIELD, O.—Bids will soon be asked for constructing a $12,000 pump and boiler house, according to reports.

ALBANY, IND.—It is stated that works will soon be put in.

ANGOLA, IND.—Chas. V. Foulk, Town Clk., writes us that a petition will soon be presented asking for an election to vote on the question of works.

BORDEN, IND.—The construction of the proposed works is expected to be commenced within a few days. Engr., W. N. Morrill; Supt., G. W. Miller.

HUNTINGTON, IND.—The trustees have voted to purchase a new 2,500,000-gallon pump.

CRESWELL, MICH.—The citizens have voted to issue $9,000 in bonds for works.

EATON RAPIDS, MICH.—It is reported that works will be put in.

MONTAGUE, MICH.—The citizens have voted to make extensions.

TRENTON, MICH.—A special election will probably be held soon to vote on the question of works.

AURORA, ILL.—J. M. Kennedy, Cy. Clk., writes us that the proposed extensions, estimated to cost $20,000, will be made by the city under the supervision of the superintendent.

CHICAGO, ILL.—Bids will soon be asked for the construction of a new intake tunnel about four miles in length——Bids are asked until Aug. 14 for laying service pipes in 11 streets. H. J. Jones, Comr. Pub. Wks.

VERMONT, ILL.—An election was held Aug. 7 to vote on the question of works.

WAUKEGAN, ILL.—Contracts have been awarded as follows: Intake pipe, Mr. Gaylord, at $23,450; power house, S. I. Pope & Co., $4,697; boilers, Wm. Wright, $2,729; pumps and engines, Wm. Wright, $8,200; distribution system, Sydney & Williams, $12,995.

CADOTT, WIS.—The village is reported as preparing to put in works.

GRUNDY CENTER, IA.—An abundant artesian supply has been secured and there is talk of laying a main to Holland.

LISBON, IA.—The citizens have voted to issue $13,000 in bonds for works and electric light.

OAKLAND, IA.—Bids are asked until Aug. 14 for constructing works, including a 500,000-gallon pump, 35-HP. boiler, 2,500 ft. of 6-in. pipe, 6 hydrants and a stand-pipe or tank. Ed. Port, Recdr.

BLUE EARTH CITY, MINN.—C. N. Brown, Cy. Recdr., writes us the contract for works has been awarded to Fairbanks, Morse & Co., St. Paul, at $12,780.

MARSHALL, MINN.—C. F. Case, Village Pres., writes us that the contract for constructing works, including well and electric light plant, has been awarded to E. T. Sykes, Minneapolis, at $23,890. The contract for the well was sublet to A. Swanson, who bid $1,785 for a well 400 ft. deep and $3.50 for each additional foot.——The city has sold $25,000 of water bonds for $27,305.

NORTHFIELD, MINN.—The contract for works has been awarded to Million & Young, at $32,540, not including rock excavation or laying pipe under the river, which makes the next to the lowest bid as shown below much the lowest. The works will cost about $36,000. The bids were as follows; Engr., Chas. F. Loweth, St. Paul:

Fairbanks, Morse & Co., St. Paul	$31,936
Million & Young, St. Paul	32,540
Geo. R. King & Co., Duluth	32,639
Tobin & Gleason, Minneapolis	34,850
Sykes & Wagner, Minneapolis	34,858
Rinker & Hoff, Minneapolis	35,700
C. W. Hubbard, Sioux Falls, S. Dak	36,361
Abbott & Youngreen, Minneapolis	36,644
John Grant, Faribault	36,668
H. C. Olson & Co., Stillwater	37,595

PRESTON, MINN.—Wm. J. Hey, Village Recdr., writes us that the election to vote on an issue of bonds for $8,000 for works has been postponed. An engineer will probably be asked to submit estimates.

RUSHFORD, MINN.—Bids are asked until Aug. 22 for 10,000 ft. of 8 to 4-in. pipe, 20 hydrants, etc., for constructing works estimated to cost $12,000; also until Sept. 1 for the purchase of $10,000 in 5½% bonds. F. A. Olson, Cy. Clk.

ST. JAMES, MINN.—Chas. F. Loweth, Engr., St. Paul, writes us that bids were opened July 31 for works and the contract awarded to E. T. Sykes for the complete works. The bids were as follows:

Fairbanks, Morse & Co., St. Paul	$21,882
Million & Young, St. Paul	21,976
Lafayette Shaw, St. Paul	25,300
Thos. Davis, St. Paul	20,000
E. T. Sykes, Minneapolis	20,569
Tobin & Gleason, Minneapolis	21,000
C. W. Hubbard, Sioux Falls, S. Dak	20,940
Kirkland & Starkey, St. Paul	23,500
O. H. Olson, Stillwater	21,965

WELLS, MINN.—The citizens have voted to issue $20,000 in bonds for works and electric lights.

CEDAR RAPIDS, NEB.—Bids are asked until Aug. 28 for the construction of works estimated to cost $9,000. Engr., G. H. Ellsworth, Fullerton, Neb. Village Clk., E. L. Sargent.

WAKEFIELD, NEB.—The town is reported as arranging with Mr. Page, of the Iowa Construction Co., Sioux City, for the construction of works.

GRAND FORKS, N. DAK.—The council has voted to purchase land opposite the pumping station for a complete filter plant like that at Lawrence, Mass., according to reports; estimated cost, $40,000. Cy. Engr., W. S. Russell.

COLEMAN, TEX.—J. K. Baker, Cy. Secy., writes us that the city will soon issue $15,000 in 6% water-works bonds.

LOTT, TEX.—A water company is reported as about to put in works.

SHINER, TEX.—An artesian supply has been secured and there is talk of arranging to use it for fire protection, according to report.

WICHITA FALLS, TEX.—It is stated that the Consolidated Engineering Co., St. Louis, will put in works and an electric light plant.

KINGFISHER, OKLA.—The Kingfisher Water & Mining Co. has been organized with a capital stock of $2,500; directors, D. K. Cunningham, W. F. Bart, J. C. Gross, J. C. Caldwell and others.

BALLARD, WASH.—E. O. Marsh, Cy. Clk., writes us that the question of issuing $50,000 in bonds for works and electric lights will be voted upon Sept. 10. Cy. Engr., S. K. Smith.

COLTON, CAL.—D. Johnson, Cy. Clk., writes us that it is proposed to purchase the old plant for $40,000 and spend $24,000 for extensions, but these have not been definitely decided upon; supply from artesian wells. Engr., J. T. Taylor, Riverside.

AYLMER, QUE.—It is reported that an election will soon be held to vote on an appropriation of $33,000 for works.

ARTESIAN WELLS.

AUSTIN, ILL.—Bids are asked until Aug. 25 for drilling and casing a deep well at Berwyn, etc., as stated in our advertising columns. Ed. G. Austin, Town Clk.

MITCHELL, S. DAK.—It is stated that the council has spent several thousand dollars in attempts to sink an artesian well, and that a new contract will soon be awarded.

ENNIS, TEX.—The city has purchased machinery and will bore an artesian well.

IRRIGATION.

BROWNWOOD, TEX.—A press report states as follows: Mr. Ingle, representing a California irrigation company, met on July 28 a large and enthusiastic number of the people of Brown county who inhabit the Pecan valley and tributaries thereto. His proposition is to furnish a system of irrigation ditches to irrigate the valley of the bayou and the creeks running into it for the sum of $3.30 per acre for ten years, provided the people will irrigate 50,000 acres. A committee of three for every three miles of bayou front was selected to canvass the territory prescribed and get land subscribed, the committee to report at a meeting to be held here Aug. 5.

MODESTO, CAL.—The only bids received by the Modesto irrigation district for the completion of the headworks, flumes, tunnels, cement work, etc., was that of the San Francisco Bridge Co., at about $64,000.

ST. JOHNS, ARIZ.—It is stated that a reservoir is being built at Salado, six miles south of this city, which will store water to irrigate 3,000 acres.

NEW COMPANIES.—Beaver Creek Irrigating Co., Saco, Valley county, Mont.; $5,000; Archie Blue, David Kennedy and Clarence Broadbrooks.

SEWERS.

GARDINER, ME.—Frederick Danforth, Gardiner, and E. C. Jordon, Portland, have reported plans for a system 23,000 ft. in length, estimated to cost $23,000.

CONCORD, N. H.—The following bids have been received for proposed sewers: W. S. Marsh, Lawrence, $4,292; J. M. Drew & Co., Malden, $4,247; Geo. M. Atkins & Co., Palmer, $4,136; Chester V. Carleton, Milford, $3,584.

ATHOL, MASS.—E. V. Wilson, Chn. Com., writes us that the lowest bid for constructing the proposed sewers was that of Gennaro, Long & Little, South Braintree, at $34,010. D. O'Connell & Son, Holyoke, bid $35,645 and the highest bid was $57,337. The itemized bids will be published in a later issue.

BROCKTON, MASS.—The council has authorized an additional issue of $10,000 in bonds for sewer extensions.

FAIRHAVEN, MASS.—The selectmen have voted to issue $50,000 in bonds for constructing a system. It is stated that the Shone system will probably be adopted.

MALDEN, MASS.—Sewer bonds for $100,000 have been sold to R. L. Day & Co. for $106,415.

TAUNTON, MASS.—The aldermen have voted to appropriate $60,000 for constructing sewers.

WESTBORO, MASS.—A committee consisting of W. H. Walker, J. E. Beeman and G. L. Smith, has been appointed to investigate the question of constructing a system.

PROVIDENCE, R. I.—Bids are asked until Sept. 1 for furnishing three sewage pumping engines with boilers, as stated in our advertising columns. R. E. Smith, Comr. Pub. Wks.

BROOKLYN, N. Y.—Bids are asked until Aug. 21 for constructing sewers in district 39, subdivision No. 5. A. T. White, Comr. Cy. Wks.

LITTLE FALLS, N. Y.—The trustees have directed the clerk to advertise for bids for constructing a 48 or 36-in. iron pipe outlet sewer.

NEW YORK, N. Y.—Bids are asked by the department of public works until Aug. 15 for constructing sewers in two streets.——Contracts have been awarded as follows: H. J. Devlin, $6,826 for a sewer in Washing Ave., and W. Murray, $2,169 for one in Eagle Ave.; the lowest bid for sewers in 149th St. was that of B. C. Murray, at $20,051.

NIAGARA FALLS, N. Y.—The board of public works has voted to construct a system to drain four square miles, in the eastern part of the city; cost, $160,000.

ROCHESTER, N. Y.—The council has adopted ordinances for constructing 18 to 12-in. pipe sewers in five streets, estimated to cost about $21,000. H. W. Gregg, Cy. Clk.

PLAINFIELD, N. J.—Bids are asked until Aug. 21 for the construction of 27,485 ft of 18 to 8-in. pipe sewers, as stated in our advertising columns. Each proposal must be accompanied by a certified check for $1,000 payable to the treasurer of the city, and a bond of $10,000 will be required of the successful bidder. The contract must be executed within six days after date of award and the work commenced within ten days after the execution of the contract. Jas. T. MacMurray, Cy. Clk.

JEANNETTE, PA.—Plans are reported as about completed for building 2,791 ft. of brick sewers, estimated to cost $12,000. C. F. L. McQuistion, Butler, Pa., has been engaged to prepare plans for a complete system.

PITTSBURG, PA.—G. F. Egan has been awarded a contract for constructing a sewer in Braddock Ave., at $18,011.

SHARON, PA.—Potter & Folwell, Pittsburg, have been engaged to design a system.

SWARTHMORE, PA.—The citizens voted to spend $16,000 for sewers and improving the streets.

BALTIMORE, MD.—Bids are asked until Aug. 20 for furnishing materials for a sewer in Fort Ave. A. E. Smyrk, Cy. Comr.

CLEVELAND, O.—Bids are asked until Aug. 15 for constructing a sewer in Bright St. J. H. Farley, Dir. Pub. Wks.

DAYTON, O.—Bids are asked until Aug. 13 for constructing a sewer in Keowee St. C. A. Herbig, Cy. Comptroller.

HAMILTON, O.—Bids are asked until Aug. 23 for the purchase of $35,000 of 4½% sewer bonds. John Helvey, Pres. Council.

ZANESVILLE, O.—Bids are asked until Aug. 25 for constructing sewers. W. M. Shinnock, Jr., Cy. Clk.

CHICAGO, ILL.—Bids are asked until Aug. 14 for laying private drains in Kedzie Ave. H. J. Jones., Comr. Pub. Wks.

LAMBERTON, MINN.—Bids are asked until Aug. 27 for the purchase of $5,000 in 5-year 6% bonds, issued for water-works and sewers. G. R. Tretbar, Village Recdr.

ST. JAMES, MINN.—Chas. F. Loweth, Engr., St. Paul, writes us that the following bids have been received for constructing 3,240 ft. of 12-in. pipe sewers:

Million & Young, St. Paul	$2,470
Anderson & Lindquist, St. Paul	1,990
P. H. Thornton, St. Paul	1,902
Linnebauner & Hiddel, Mankato	2,770
W. W. Sykes, Minneapolis	2,096
Cody Henline Co., Minneapolis	4,113
E. T. Sykes, Minneapolis	2,687
Tobin & Gleason, Minneapolis	2,481
Frank Jackson, Hastings	4,209
Caney Bros., Minneapolis	2,103
Kirkland & Starkey, St. Paul	2,101
Hans Olson, St. James	2,169
Abbot & Youngren, Minneapolis (a'w'd contract)	1,816
C. W. Hubbard, Sioux Falls	2,914
A. W. Sweppe, St. James	2,429

ST. PAUL, MINN.—Bids are asked until Aug. 13 for constructing sewers in Edgerton and Edmund Sts. J. C. Mueller, Clk. Bd. Pub. Wks.

LAWRENCE, KAN.—Bids are asked until Aug. 18 for constructing 6,100 ft. of 12 to 8-in. sewer pipe drains. P. Laptad, Trustee, Grant Township.

SEATTLE, WASH.—The board of public works has readvertised for bids for constructing sewers in Renton Ave. The following bids were received July 27 for the work, but were all rejected: M. O'Day, $3,808; C. J. Erickson, $2,823; Ryan & Wolfe, $3,047; Jas. A. Huey and L. Peters, $3,840; McDonald & Holt, $4,137; J. F. Garretty, $3,702; J. A. Bailey, $3,836.

STREETS.

BROOKLYN, N. Y.—Bids are asked until Aug. 13 for reconstructing the roadways of the Brooklyn Bridge at the Brooklyn station. C. C. Martin, Ch. Engr. and Supt.——Bids are asked until Aug. 15 for paving with cobblestones, and until Aug. 17 for paving with cobblestones and granite blocks. A. T. White, Comr. Cy. Wks.

NEW YORK, N. Y.—Bids are asked by the department of public works until Aug. 15 for paving portions of 10 streets with asphalt and for grading and improving two streets.——Bids are asked by the commissioner of street improvements of the 23d and 24th wards, 2622 Third Ave., until Aug. 16 for paving two streets with granite blocks and for improving one street.

ROCHESTER, N. Y.—The council has adopted ordinances for macadamizing two streets, estimated to cost $21,800, and constructing cement sidewalks in five streets, estimated to cost $3,750. H. W. Gregg, Cy. Clk.

SALAMANCA, N. Y.—The contract for paving Main St. has been awarded to Sheehan & McGhann, Bradford, at $7,300.

SCHENECTADY, N. Y.—Bids are asked by the council until Aug. 14 for paving and curbing East Liberty St. and Summit Ave. L. B. Sebring, Cy. Engr.

WATERTOWN, N. Y.—The Watertown Paving Co. has been organized to construct cement and granite sidewalks, etc. Secy., H. E. Baker; Supt., T. P. Lewis.

ALLEGHENY, PA.—The public works committee has recommended that contracts for paving be awarded as follows: Sicilian Asphalt Paving Co., five contracts, at $76,382; Sloan & McIlvain, Ligonier blocks, five contracts, at $71,820; A. V. Purnell, asphalt and Ligonier blocks, three contracts, at $64,065; A. Neillie & Co., asphalt blocks, one contract, at $14,111.

WASHINGTON, D. C.—Bids are asked until Aug. 20 for furnishing paving brick, asphalt blocks and sewer brick, as stated in our advertising columns. J. W. Ross, Geo. Truesdall, C. F. Powell, Comrs.

CINCINNATI, O.—Bids are asked by the board of administration until Aug. 15 for paving Corporation Alley with granite blocks.

MARION, O.—Bids are asked until Aug. 21 for the purchase of $20,000 of 6% paving bonds.

YOUNGSTOWN, O.—Bids are asked until Aug. 13 for the purchase of $14,000 of 6% paving and $1,400 of 6% sewer bonds. J. H. Edwards, Cy. Clk.——The following bids have been received for paving Federal St. with Brady Run brick: G. D. & W. S. Hersey, $12,460; Davis & Caldwell, $13,370; J. B. Finch, $13,995; Con O'Donnell, $13,930; G. J. Vetter, $14,200; F. E. Gribbon, $12,765.

CRAWFORDSVILLE, IND.—Bids are asked until Aug. 20 for building brick sidewalks. J. M. Naugh, Cy. Engr.

LANSING, MICH.—The board of public works has been authorized to advertise for bids for paving Washington Ave.

RACINE, WIS.—It is proposed to pave Main St. with cedar blocks at an estimated cost of $24,232.

MARSHALLTOWN, IA.—Bids are asked until Aug. 13 for 21,000 sq. yds. of brick paving and 7,200 lin. ft. of curbing. J. G. Trotter, Cy. Clk.

MUSCATINE, IA.—Contracts for brick paving have been awarded as follows: McGugin & McRae, Davenport, $18,438; Des Moines Brick Co., Des Moines, $20,088; Becky, Hayde & Co., Muscatine, $16,335 and $12,167.

ST. PAUL, MINN.—The board of public works has adopted ordinances for paving Fourth and Seventh Sts. with asphalt.

WACO, TEX.—It is proposed to issue $80,000 in street and $25,000 in sewer bonds.

SAN FRANCISCO, CAL.—The Alcatraz Asphalt Co. has been incorporated with a capital stock of $1,000,000, by W. N. Cowles, F. N. Vail, G. E. Hall and A. C. Ferry.

ELECTRIC LIGHT AND POWER.

BROOKLYN, N. Y.—The New York State Electric Light & Power Co., Pres., N. L. Cochen, has increased its capital stock from $200,000 to $500,000.

JAMESTOWN, N. Y.—Bids are asked until Aug. 15 for furnishing and installing boilers, engines, dynamos, etc., also for erecting an addition to the electric light plant building, as stated in our advertising columns. Engr., E. C. Burns.

PADUCAH, KY.—A contract has been made with the Consolidated Engineering Co., St. Louis, for the erection of an electric light plant.

CENTERVILLE, MICH.—It is reported that this city will put in an electric light plant.

GLADWIN, MICH.—The council has passed an ordinance providing for electric street lighting.

HART, MICH.—The citizens have voted to put in an electric light plant.

MINDEN CITY, MICH.—It is stated that the question of electric lights is being discussed.

OTSEGO, MICH.—It is stated that Geo. C. and B. A. Nevins have purchased water power a mile from the village and will put in an electric lighting plant.

SOUTH HAVEN, MICH.—A 10-year franchise has been granted to G. W. Furbeck and I. D. Hamilton for electric lighting.

ST. CHARLES, MO.—A 20-year franchise has been granted to A. D. Williams and G. O. McGee for an electric light plant.

NEVADA CITY, CAL.—M. L. McDonald, of Santa Rosa, and C. W. Cross, San Francisco, have been investigating a proposition for putting in an electric light plant. Water power would be used.

MONTREAL, QUE.—Bids are asked until Aug. 15 for building a dam across the Richelieu River, turbines for 500 HP., and for furnishing wire, electrical machinery, etc., for transmitting 15,000 HP. from Chambly to this city (extension of time from Aug. 1). C. D. Gaudet, Secy., Chambly Mfg. Co., New York Life Bldg., Montreal.

NEW COMPANIES.—Seashore Electric Light & Power Co., Asbury Park, N. J.; $100,000; J. C. Shaffer, Evanston, Ill.; W. H. Shaffer and I. C. Kennedy, Asbury Park.——Brodie Electric Co., Manchester, N. H.; $25,000; Pres., J. B. Smith; Treas., W. G. Africa.——Robertson Insulated Conduit Electric Co., Chicago, Ill.; $1,000,000; J. L. Murphy, S. H. Bracey, H. B. McMillian.——Hellersted Carriage Co., Fulton, Ill.; amended its charter so as to do an electric light business and increased its capital stock from $20,000 to $50,000.——Union Gas & Electric Light Co., Saratoga Springs, N. Y.; $60,000; C. E. Arnold, E. J. Slattery, Albany; E. H. Peters, Saratoga Springs.——Electric Light, Power & Water Co., Sea Isle City, N. J.; $50,000; Morris Boney, J. A. McCullough, J. McGinnis, J. E. Conway, Philadelphia; John Hough, Sea Isle City.——Solano Electric Light Co., Benicia, Cal.; $10,000; Thomas McKay, Kennet Chisholm, Murdock McArthur, Benicia; George Frane, Elmira.

MISCELLANEOUS CONTRACTS AND SUPPLIES.

BUILDINGS.—Brooklyn, N. Y.—It is stated that five new iron and steel buildings will soon be constructed at the navy yard.

FIRE BOAT.—Boston, Mass.—Bids are asked until Aug. 25 for building a propeller fireboat. Robt. G. Fitch, Chn. Fire Comrs.

LOCK HOUSES.—Louisville, Ky.—Bids are asked until Sept. 6 for building two new lock houses. Capt. J. G. Warren, U. S. Engr. Office.

DRAINAGE.—Mallorytown, Ont.—Bids are asked until Aug. 11 for 11 miles of drainage work. Engr., B. J. Saunders, Brockville. John F. Kelly, Clk.

CANAL.—Fresno, Cal.—Louis Manuel, Engr., has reported that the proposed canal to the head of navigation on the San Joaquin River can be constructed for $138,000.

DISINFECTING PLANT.—Washington, D. C.—Bids are asked until Aug. 28 for a disinfecting plant for the U. S. quarantine station, San Diego, Cal. Jeremiah O'Rourke, Supervising Arch., Treasury Dept.

WHARF REPAIRS.—Washington, D. C.—Bids are asked until Aug. 23 for repairs to wharf at U. S. quarantine station, Blackbeard Island, Sapelo Sound, Ga. Jeremiah O'Rourke, Supervising Arch., Treasury Dept.

OPERATING MACHINERY.—Detroit, Mich.—Bids are asked until Sept. 5 for operating machinery for the 300-ft. lock at St. Mary's Falls canal, as stated in our advertising columns. Col. O. M. Poe, U. S. Engr. Office.

EXCAVATION.—Seattle, Wash.—The capitol commission has voted to advertise for bids for grading and excavating for the new building, for which plans have just been completed by Ernest Flagg, New York; estimated cost of building, $1,000,000.

DREDGING, ETC.—Albany, N. Y.—Bids are asked until Aug. 17 for removing the bars and dredging the channel of Cayuga inlet; removing obstructions in Cayuga Lake; and for making improvements and repairs to the Rocky Rift feeder. Edward Hannan, Supt. Pub. Wks.

NATURAL GAS PUMPING STATION.—Kokoma, Ind.—The "Tribune" states that the Indianapolis Natural Gas Co. has purchased land in White River township, Hamilton county, on which to build a gas pumping station estimated to cost $400,000; also that the Consumers' Gas Trust Co. is digging new wells and will pump gas within a year.

CONTRACT PRICES.

ASPHALT PAVING.—Kansas City, Mo.—The contract for paving Fifth St., from Main to Walnut Sts., with asphalt has been awarded to the Barber Asphalt Paving Co., at $2.65 per sq. yd.

Dayton, O.—The "Times" states that the Warren-Scharf Asphalt Paving Co. was the lowest bidder for the asphalt paving recently advertised, the bid being $2.61 per sq. yd., on all but one street, and the Trinidad Asphalt Co. bidding $2.66 on the same streets.

STONE PAVING—Schenectady, N. Y.—The contract for paving lower State St. with granite blocks has been awarded to Robt. Strong, Albany, N. Y., at $15,111; Cy. Engr., L. B. Sebring. The bids were as follows:

	Paving, per sq. yd.	Curbing, per lin. ft.
Divine & Veeder, Schenectady	$2.38	$1.09
John Towmey & Co., "	2.34	.80
Robt. Strong, Albany	2.45	.51

Hartford, Conn.—The following bids were received for paving Union Place with granite blocks: A. E. Lyon, Springfield (by telegraph), West Dummerston granite, $3.10 per sq. yd.; C. W. Blakeslee & Sons, New Haven, Lyon Granite Co.'s blocks, $3.95; Fiege & Langefield, Waterbury, Lyon blocks, $3.37; Webb blocks, $3.71; New England Granite Co.'s blocks, $3.85; H. E. Billings, Hartford, New England Granite Co.'s or W. N. Flynt Co.'s blocks, $4.65; Michael O'Neil, Hartford, $3.93; New England Granite Wks., Hartford, $4.30; Concord blocks, $4.15; Edward McManus, Waterbury, Lyons blocks, $4.53; Webb blocks, $4.94; New England Granite Co.'s blocks, $5.09.

BRICK PAVING—Kansas City, Kan.—C. A. Ellis, Cy. Engr., writes us that a contract for 4,000 sq. yds. of paving with vitrified brick on 4 ins. concrete has been awarded at $1.29½ per sq. yd.

Johnstown, Pa.—A contract for paving with Mack Mfg. Co.'s vitrified fire brick upon 8 ins. gravel and 2 ins. sand has been awarded to J. C. McSpadden, at $1.39 per sq. yd. The other bidders were R. A. Richards, W. A. Park and John Best.

Owego, N. Y.—Bids for paving Lake St. with brick ranged from $1.65 to $2.43 per sq. yd., the lowest bidders being W. E. Warren, Hornellsville, and Costello & Neagle, Elmira, according to reports. The other bidders were Clark & Beardslee, Elmira; Homer & Co., Elmira; C. A. Rubridge, Corning; Campbell & Wood, Ithaca.

New Castle, Pa.—Contracts for paving with brick have been awarded to E. M. Ayers, at $1.27 per sq. yd. for

Park brick with pitch filling, and M. S. Marquis, at $1.03 for Marquis brick; excavation, 20 cts.; curbing, 33 cts.; old curbing, 17 cts.

Zanesville, O.—The following bids were received for paving South Linden Ave. with brick:

	Otho Ebert.	E. J. Tracy.	P. M. Pelit.	Evans & Dunzweiller.	Rosser & Haas.	E. M. Ayers.
Grading, per cu. yd.	$.24	$.30	...	$.45	$.25	$.30
Sand, "	.05	...	...	.08	...	...
Harris brick, per sq. yd.	.70	.75	$.83	.94	.79	.80
" No. 2 " "	.71	...	...	.84	...	.62
Sandstone curb, per lin. ft.	.36	.43	.39	.32	.31	.40
Limestone " "	.46	.50	.52	.41	.38	.50
Reset'g old curb, "	.12	.20	.20	.16	.38	.20

Muscatine, Ia.—Bids were opened July 26 for about 50,000 sq. yds. of paving with one course of brick upon macadam. Becky, Hayde & Co., Muscatine, and the Des Moines Mfg. Co., Des Moines, each bid $1.08 per sq. yd., according to reports. The other bidders were: Edwards & Walsh Construction Co., Davenport; Geo. Kriechbaum, Burlington; Flint Brick Co., Des Moines; Jas. H. Selden, Muscatine; McGregor & McGugin, Davenport; Rockford Construction Co., Rockford, Ill., and Berry & Welch.

Kansas City, Mo.—The contract for paving Santa Fe St., from Union Ave. to St. Louis Ave., with vitrified brick, has been awarded to J. E. Farris, at $1.54 per sq. yd.

Covington, Ky.—Thos. H. Kennedy, Cy. Engr., writes us that 14 bids were received for the brick paving recently noted and that all the prices were considered very low. Contracts were awarded as follows: John McKnight, Covington, 5,690 sq. yds. of paving at $1.20; 2,480 lin. ft. of curbing at 55 cts.; 1,800 cu. yds. of grading at 18 cts.; 970 cu. yds. of concrete at $3; 188 lin ft. of common curbing, at 18 cts.; 40 ft. of pipe sewer at $1; total, $11,620. Ben Dresman, 3,750 sq. yds. of paving, at $1.26; 1,660 lin. ft. of 5-in. curbing, at 55 cts.; 300 cu. yds. of grading, at 15 cts.; 640 cu. yds. of concrete, at $2.90; 148 lin. ft. of curbing, at 20 cts.; 40 ft. of pipe sewer, at 50 cts.; total, $7,739. The Mack Manigal block, made at Middleport, O., will be used in both streets.

Columbus, O.—The bids for paving Eighth Ave., from Neil Ave. to Perry St., with Hallwood blocks were as follows: N. B. Abbott, $1.38 per sq. yd., including tar filling and stone foundation; McCloud & Geigele, $1.60; W. H. Lupton, $2.

Cincinnati, O.—Press reports state that very low bids were received July 27 for paving alleys with brick, some of the lowest being Henkle & Sullivan, at $1.05 and $1.22 per sq. yd. for Hallwood blocks, and Henry Diekmier, at $1.25.

Springfield, Ill.—The contract for paving to the Fair grounds has been awarded to John Cherry, Jacksonville, at $1.20 and $1.25 per sq. yd., including curbing. It is stated that the work will require 2,000,000 brick. The other bids were as follows:

	Paving, per sq. yd.	Curbing, per lin. ft.
Henry Nelch	$1.03 and $1.15	$0.46 to $0.50
A. Mayfield	1.15	.50
Winona Construction Co.	1.27	.39
John Striffler & Co.	1.19 " 1.29	.44 " .50
John F. Bretz & Son	1.10 " 1.48	.44 " .49
Rockford Construction Co.	1.24 " 1.39	.37 " .40
Thomas White	1.14⅝ " 1.43	.47 " .55
N. P. Bland Const'n Co.	1.15 " 1.25	... .38
Joseph W. Vance	1.12 " 1.24	.35 " .38

PIPELAYING.—Glens Falls, N. Y.—The contract for laying about 22,000 ft. of 20 and 24-in. cast iron pipe to the Keenan reservoir has been awarded to John Riley and C. J. Riordan, at 45 cts. per lin. ft. for 20-in. pipe and 55 cts. for 24-in.

REMOVING LEDGE.—Newport, R. I.—Capt. W. H. Bixby, U. S. Engr. Office, informs us that the contract for removing ledge rock in the Pawtucket River will probably be awarded to Rogers & Fitzpatrick, the bids per cu. yd. being as follows:

Rogers & Fitzpatrick, Plattsburgh, N. Y.	$7.74
Wellington & Johnson, New York	14.00
P. Sandford Ross, Jersey City, N. J.	19.00
Johnston & Townsend, Somers Point, N. J.	12.20
Thos. A. Scott, New London, Conn.	9.90
Geo. W. Townsend, Boston, Mass.	9.93
Geo. W. Andrews, Biddeford, Me.	8.37

SEWER BRICK.—Minneapolis, Minn.—The following contracts have been awarded for brick to be used in constructing the 26th St. south sewer, 2d St. south and the Bryn Mawr sewers:

Northwestern Pressed Brick Co.	500,000, per M.	$6.50
" " " "	500,000 " "	6.75
Wisconsin Red Pressed Brick Co.	500,000 " "	6.95
John A. Berg.	250,000 " "	6.97
Philip Riedell	1,000,000 " "	6.73

GRADING.—Kansas City, Kan.—A contract for 43,000 cu. yds. of grading has been awarded to Chas. Craw, at 15.99 cts. per cu. yd. Cy. Engr., C. A. Ellis.

HIGHWAY IMPROVEMENTS.—Cincinnati, O.—The following bids were received by the county commissioners for improving Asbury road; engineer's estimate, $32,000:

	Cu. yds.	Ruffner Bros.	Link & Co.	M. H. Burke & Anderson.	J. S. Kelnath.	H. Nagle.
Grading,	40,000	$.22	$.23	$.24	$.15	$.15
Masonry,	200	7.50	8.00	7.75	8.00	5.50
Brk'n stne,	7,000	1.25	1.44	1.55	.75	1.30
Gravel	2,000	1.75	1.57	1.90	1.35	1.10
Drain pipe:						
12-in.,	150 lin. ft.	.50	.75	1.00	.40	.25
15-in.,	150 " "	.75	.75	1.10	.40	.35
18-in.,	400 " "	1.00	1.25	1.25	.50	.60
Pav'g,	120 sq. yds.	1.00	1.00	1.25	1.65	.50
Lmbr,	3½ M. ft. B. M.	25.00	25.00	22.00	20.00	2.50
Total		$23,325	$24,955	$26,842	$16,138	$18,799

SEWERS.—Charlottesville, Va.—N. Wilson Davis, Engr. in charge, writes us that the following bids were received for the proposed sewers recently advertised in this paper:

Bids Received at Charlottesville, Va., for Constructing Sewers.

Names.	20-in. pipe, 4,000 ft.	18-in. pipe, 8,300 ft.	15-in. pipe, 2,675 ft.	12-in. pipe, 440 ft.	10-in. pipe, 2,380 ft.	8-in. pipe, 38,500 ft.	Concrete, per cu. yd.	Hard rock, per cu. yd.	Loose rock, per cu. yd.	Manhole covers, 83, 650 lbs.	Brick laid, 300 M.	Tunnel as specified.	Totals.
	$	$	$	$	$	$	$	$	$	$	$	$	$
B. J. Coyle, Washington, D. C.	1.35	1.08	.85	.74	.68	.54	5.25	2.70	.10	.02	19.50	4,750	51,713
John Jacoby, Wilmington, Del.	.96	.80	.72	.50	.48	.55	4.00	1.50	.75	.01¼	18.25	2,000	43,949
Gantz & Sullivan, Columbus, O.	1.10	.94	.63	.50	.42	.52	4.00	3.00	.60	.02½	14.25	1,235	42,778
Lane Bros. & Co., Charlottesville, Va.	1.00	.85	.71	.57	.48	.42	2.40	1.30	.30	.02½	13.00	2,000	38,568
T. L. Rosser, Charlottesville, Va.	1.02	.82	.70	.53	.46	.39	5.00	3.50	.75	.02	15.00	2,100	37,444
Geo. Dale Wadley & Co., Macon, Ga.	.97	.80	.64	.50	.42	.37	5.00	.95	.60	.02⅝	15.00	2,015	36,548
C. M. Braxton, Newport News, Va.	.95	.90	.60	.50	.42	.40	6.00	1.00	.60	.02	20.00	2,000	37,614
Greenville Const'n Co., Greenville, O.	.88	.70	.55	.40	.38	.35	4.00	1.75	1.00	.02	15.00	1,600	33,220
Rutherford & Brown, New York	.69	.58	.48	.37	.35	.34½	6.50	3.00	1.50	.04	15.00	1,673	32,647
Geo. Acock & Son, Trenton, N. J.	.75	.63	.53	.43	.38	.34	5.00	2.00	2.00	.02	15.00	2,060	32,100
Sandford & Brooks, Baltimore, Md.	.79	.67	.56	.47	.395	.30½	3.25	1.27	.43	.022	11.95	2,007	31,576
Dunn & Lollande Bro., Brmghm., Ala.	.85	.67	.54	.45	.41	.33½	3.00	.78	.29	.02½	10.75	1,494	31,244
Hankins, Mosby & Co., Richmond, Va.	.85	.69	.55	.43	.39	.33	4.50	2.85	.75	.02¼	16.00	2,500	31,145
A. H. Gentry, Charlottesville, Va.	.7557	.6116	.501	.3746	.3014	.34	2.75	.98	.35	.02	12.90	1,485	30,479
Guild & White, Chattanooga, Tenn.	.75	.61	.48	.40	.34	.33	4.00	2.00	.40	.01½	13.00	1,720	29,962
Va. P'v'g & Const'n Co., Lynchb'g, Va.	.72	.62	.51	.43	.35	.32	3.90	2.50	.65	.01¾	15.00	985	29,722
Vaughn & Luch, Roanoke, Va.	.81	.66	.54	.39	.33	.30	2.95	.75	.35	.01½	8.25	1,200	27,707

PUMPING ENGINES.—Bloomington, Ill.—The contract for a 4,000,000-gallon pumping engine has been awarded to Henry R. Worthington, at $9,000, according to the local papers.

SAND.—Baltimore, Md.—The following bids were received last week for furnishing sand for paving streets:

	Pratt St., 13,000 cu. yds.	Holliday St., 6,000 cu. yds.	Gay St., 3,500 cu. yds.
Wm. E. Anderson, at	$.33⅓	....	$.34½
Patrick Kealty	..	....	.84
George Kline	.35	....	..
I. S. Filbert	.37	$.43	.51
J. J. Gallagher & Co.	.37	....	.40
Smith & Brady	.43	....	..
Frank Fallon	..	.27	.35
John Flannery	..	.38	..
Henry Kline	..	.40	..
P. Flannigan & Co.	..	.48	..

SEWERS.—Washington, D. C.—John Walker, Ch. Clk., writes us that the following bids were received July 28 for constructing sewers, the price being per lin. ft. for each sewer and the price for each manhole:

Philadelphia, Pa.—Jas. H. Windrim, Dir. Dept. Pub. Wks., informs us that contracts for main sewers were awarded last week as follows: Allegheny Ave., to R. P. Bonnis, 433 E. Chelten Ave., 105-in., 720½ ft., $19.50 per lin. ft.; 90-in., 392 ft., $16; 78-in., 804 ft., $13; 75-in., 942 ft., $13; chamber, $850; total, $44,042. Botanic Creek, to J. S. Kite & Co., 523 N. 40th St., 72-in., 300 ft., $7.38; 66-in., 261 ft., $7.72; 54-in., 1,010 ft., $7.34; 54-in., 1,122 ft., $6.90; 59-in., 1,478 ft., $10.66; 36-in., 241 ft., $4.98; 42 × 28-in., 876 ft., $3.33; chamber, $980; total, $40,238. Morion Creek, to John A. Kelley, 8 South Broad St., 108-in., 1,426 ft., $13.95; 102-in. 1,174 ft., $13.95; total, $34,875. Sylvan St., to R. P. Bonnis, 48-in., 300 ft., $6.90; 39-in., 1,170 ft., $5.40; 36-in., 405 ft., $5.40; total, $10,575. Thomas Run, to J. S. Kite & Co., 114-in., 738 ft., $13.79; 108-in., 352 ft., $13.79; total, $15,031. Venango St., to Donnelly & Scattergood, corner 5th and Master Sts., 54-in., 480 ft., $7.50; 48-in., 337 ft., $7.00; 39-in., 493 ft., $5.50; 36-in., 800 ft., $3.75; total, $11,671. Contracts were also awarded for about 90,000 lin. ft. of branch sewers in various portions of the city, amounting in all to about $240,000. The sizes varied from 12-in. terra cotta pipe to 48 × 32-in. egg-shaped brick sewer.

Bids Received at Washington, D. C., July 28, 1894, for Constructing Sewers.

Bidders.	Section A. 4-ft. brick.	Man-holes.	Section B. 2¾ × 4½-ft. brick	Man-holes.	Section C. 2 × 3-ft. brick.	Man-holes.	Section D. 2½ × 3¾-ft. brick.	Man-holes.	Section E. 2-ft. pipe.	Man-holes.	Section F. 2-ft. pipe.	Man-holes.	Section G. 4-ft. c'rete.	Man-holes.	Section H. 2¾ × 4½-ft. c'rete	Man-holes.	Section I. 2¼ × 3¾-ft. c'rete	Man-holes.	2 × 3 ft. c'rete	Man-holes.	Section K. 2½ × 2¾-ft. c'rete	Man-holes.
P. Brennan	....	....	....	....	....	....	....	....	$2.20	$25.00	$2.20	$25.00	....	....	....	....	....	....	....	....	....	....
Hussey & Brown	$8.00	$25.00	$7.80	$30.00	$7.25	$30.00	$7.00	$25.00	$6.25	$25.00	2.75	25.00	2.75	25.00	$7.75	$25.00	$7.55	$30.00	$7.50	$30.00	$6.00	$25.00
Ralph Wormley	....	....	....	....	....	....	....	....	....	....	1.60	20.00	1.66	20.00	....	....	....	....	....	....	....	....
Jas. McCandlish	5.79	22.00	7.45	38.00	5.97	38.00	5.37	38.00	5.94	25.00	1.75	27.00	1.66	30.00	5.55	22.00	....	....	....	....	5.35	25.00
M. F. Talty	6.45	25.00	8.40	35.00	8.15	35.00	6.40	32.00	6.30	30.00	1.85	25.00	1.85	25.00	....	....	....	....	....	....	....	....
*Geo. S. Good & Co.	6.60	1.00	7.75	1.00	6.60	1.00	6.00	1.00	....	....	....	....	....	....	....	....	....	....	....	....	....	....
R. H. Lamb	5.84	15.00	6.05	25.00	5.37	25.00	4.92	25.00	4.85	25.00	1.78	27.00	1.98	27.00	5.74	15.00	5.50	25.00	5.15	25.00	4.18	25.00
**E. G. Gummel	6.75	19.00	7.63	29.00	6.26	29.00	5.51	29.00	5.84	28.00	1.57	25.00	1.59	25.00	....	....	....	....	....	....	....	....
B. J. Coyle	7.25	35.00	8.30	50.00	6.40	48.00	5.85	45.00	6.80	40.00	....	....	....	....	6.90	35.00	7.75	50.00	6.00	48.00	5.50	45.00
John E. Lyons	6.39	30.00	7.24	45.00	6.36	45.00	5.67	40.00	6.15	38.00	1.95	30.00	2.09	35.00	6.25	30.00	7.20	45.00	6.05	45.00	5.55	40.00

	6.40	40.00	3.10	38.00

* Lock Haven, Pa. ** Eckington, D. C.; all others are residents of Washington, D. C.

WATER-WORKS.—Madison, Fla.—The contract for constructing water-works has been awarded to Herbert & Lapayre, Chattanooga, Tenn., at $31,700, according to plans and specifications prepared by J. F. Le Baron, Consult. Engr., Jacksonville. The work will include about 12,000 ft. of 12 to 4-in. pipe, 30 hydrants, 15 × 100-ft. stand-pipe and Pohle air-lift pump. Some of the prices of the successful bid were as follows: Pipelaying, 13 cts. per ft.; 4-in. pipe, $26 per ton, f. o. b. cars in Madison; 6-in., $23; special castings, $45; 6-in. hydrants, $23 each; setting hydrants, $4 each; best boiler iron stand-pipe, erected, 3 cts. per lb.; concrete foundations, laid, $3 per cu. yd.; pumps, $2,050.

VALVES.—Washington, D. C.—The following bids were received by the district commissioners July 28 for furnishing valves:

		M. J. Drummond New York.	Barrett Mfg. Co., Boundbrook, N. J.
3-in.,	25, each	$6.00	$4.50
4-in.,	50, "	7.50	5.60
6-in.,	200, "	11.50	9.40
12-in.,	10, "	25.90	27.00

DREDGING.—New York, N. Y.—The contract for about 200,000 cu. yds. of dredging in the North River has been awarded to P. Sanford Ross, at 19 cts. per cu. yd. Chas. Du Bois bid 19½ cts., and the Morris & Cummings Dredging Co., 19¼ cts.

BRIDGE.—Red Wing, Minn.—L. P. Wolff, Cy. Engr., writes us that the following bids were received Aug. 3 for the proposed steel bridge across the Mississippi River; Consult. Engr., C. F. Loweth, St. Paul:

Bidders	Metal in spans, per lb.	Metal in trestle, per lb.	Timber, floor-ing, per M. ft.	Railing, per lin. ft.	Total.
	cts.	cts.			
Toledo Bridge Co.	3.22	3.05	$19.00	$1.06	$29,517
Wrought Iron Bridge Co.	3.35	3.35	18.00	1.00	31,258
Missouri Valley B'dge Co.	3.25	3.15	20.00	1.25	31,259
Chicago B'dge & Iron Co.	3.49	3.49	18.00	1.00	32,361
Wisconsin Bridge Co.	3.72	3.72	21.00	1.00	33,117
Pennsylvania Steel Co.	3.64	3.50	18.50	1.62	34,401
Pittsburg Bridge Co.	3.70	3.45	25.00	1.40	35,780
American Bridge Works.	3.79	3.25	20 00	1.65	36,142
C. L. Strobel	4.00	3.60	25 00	1.45	37,277
Gillette-Herzog Mfg. Co.	3.99	2.99	17.60	1.775	37,375
King Bridge Co.	4.10	3.55	18.00	1.40	37,733
N. J. Steel & Iron Co.	4.27	4.26	18.21	1.23	39,037
Edgemoor Bridge Works.	4.21	4.26	21.00	1.75	40,157

Wisconsin Bridge Co. offered bids on its own plans, wood joists at $31,788 or steel joists at $35,284.

CONDENSED LIST OF CONTRACTS PENDING WITH DATE OF OPENING BIDS.

Bids to be opened.	Work.	Place.	See Eng. News.
Aug. 10.	Bridges, Cincinnati, O.		July 26
	Advertised, Eng. News, July 19 to Aug. 2.		
Aug. 10.	Water-works extensions, Syracuse, N. Y.		July 26
	Advertised, Eng. News, July 26.		
Aug. 10.	Asphalt paving, Troy, N. Y.		Aug. 2
Aug. 10.	Stone gutters, Baltimore, Md.		Aug. 2
Aug. 10.	Steel tanks, Savannah, Ga.		Aug. 2
Aug. 10.	Sewers, Fostoria, O.		Aug. 2
Aug. 10.	Bridge, Nevada, Mo.		Aug. 2
Aug. 10.	Pumping plant, etc., Blair, Neb.		Aug. 2
	Advertised, Eng. News, Aug. 2 and 9.		
Aug. 10.	Stand-pipe, pipe, etc., Oak Cliff, Tex.		Aug. 2
Aug. 10.	Hydrants (24), Dallas, Tex.		Aug. 2
Aug. 11.	Sewers, Sandusky, O.		July 19
Aug. 11.	Trenching, Olean, N. Y.		July 26
Aug. 11.	Electric lighting, Youngstown, O.		July 26
Aug. 11.	Sewage pumping station, Boston, Mass.		Aug. 2
Aug. 11.	Sewer materials, Rochester, N. H.		Aug. 2
	Advertised, Eng. News, Aug. 2 and 9.		
Aug. 11.	Sewers, Rochester, N. H.		Aug. 2
	Advertised, Eng. News, Aug. 2 and 9.		
Aug. 11.	Cast iron pipe, Washington, D. C.		Aug. 2
	Advertised, Eng. News, Aug. 2 and 9.		
Aug. 11.	Pipe sewers (8,300 ft.), Alliance, O.		Aug. 2

Aug. 11. Drainage work, Mallorytown, Ont....Aug. 9
Aug. 11. Bridge, Sioux City, Ia.....Aug. 9
Aug. 13. Telegraph material, Washington, D. C.July 26
Aug. 13. Macadamizing, Cincinnati, O.....July 26
Aug. 13. Sidewalks (15 streets), Houston, Tex...July 26
Aug. 13. Macadamizing (4,000 lin.ft.), Laurel, Md. Aug. 2
Aug. 13. Boilers, Toledo, O.....Aug. 2
Aug. 13. Pipe sewers, Huntington, Ind.....Aug. 2
Aug. 13. Roadways of bridge, Brooklyn, N. Y..Aug. 9
Aug. 13. Sewer, Dayton, O.....Aug. 9
Aug. 13. Paving bonds, Youngstown, O.....Aug. 9
Aug. 13. Brick paving, Marshalltown, Ia.....Aug. 9
Aug. 13. Sewers, St. Paul, Minn.....Aug. 9
Aug. 14. Brick paving, Cincinnati, O.....July 26
Aug. 14. Sewers, Buffalo, N. Y.....Aug. 2
Aug. 14. Wells, etc., Springfield, O.....Aug. 2
Advertised, Eng. News, Aug. 2 and 9.
Aug. 14. Brick sidewalks, Huntington, Ind.....Aug. 2
Aug. 14. Buildings, Ames, Ia.....Aug. 2
Aug. 14. Fire engine, Dubuque, Ia.....Aug. 2
Aug. 14. Paving, Schenectady, N. Y.....Aug. 9
Aug. 14. Private drains, Chicago, Ill.....Aug. 9
Aug. 14. Laying w. service pipes, Chicago, Ill..Aug. 9
Aug. 14. Water-works system, Oakland, Ia.....Aug. 9
Aug. 15. Architectural competition, Atlanta, Ga.July 12
Aug. 15. Water-works bonds, Hillsboro, O.....July 19
Aug. 15. Sewer bonds ($10,000), Riverside, O....July 19
Aug. 15. Electric l't plant, Summerside, P. E. I.July 19
Aug. 15. Paving (15,310 lin. ft.), Ironton, O....July 26
Aug. 15. Pumping stations, Brooklyn, N. Y.....July 26
Advertised, Eng. News, July 26.
Aug. 15. Highway, Dartmouth, Mass.....Aug. 2
Aug. 15. Highways, New York, N. Y.....Aug. 2
Aug. 15. Water-works system, Aberdeen, Md....Aug. 2
Advertised, Eng. News, Aug. 2 and 9.
Aug. 15. Court house, Bayfield, Wis.....Aug. 2
Aug. 15. Electric lighting, Trenton, Ont.....Aug. 2
Aug. 15. Electric light plant, Trenton, Ont.....Aug. 2
Aug. 15. Elec. l't plt. ext'n, Jamestown, N. Y..Aug. 9
Advertised, Eng. News, Aug. 9
Aug. 15. Cobblestone paving, Brooklyn, N. Y...Aug. 9
Aug. 15. Boilers, dynamos, etc., Jamestown, N.Y. Aug. 9
Advertised, Eng. News, Aug. 9
Aug. 15. Sewers, New York, N. Y.....Aug. 9
Aug. 15. Asphalt pav'g (10 cont's), New York...Aug. 9
Aug. 15. Granite paving, Cincinnati, O.....Aug. 9
Aug. 15. Sewer, Cleveland, O.....Aug. 9
Aug. 15. Dam, etc., Montreal, Que.....Aug. 9
Aug. 16. Water-works bonds, Glendale, O.....July 19
Aug. 16. Brick sewers (1,330 ft.), Ironton, O....July 26
Aug. 16. Pipe sewers (14,296 ft.), Ironton, O....July 26
Aug. 16. Granite paving, New York, N. Y.....Aug. 9
Aug. 17. Pipe sewers (1,559 ft.), Avondale, O....July 26
Aug. 17. Stone paving, Brooklyn, N. Y.....Aug. 9
Aug. 17. Dredging, etc., Albany, N. Y.....Aug. 9
Aug. 18. Water ext'n bonds ($2,000), Clifton, O..Aug. 2
Aug. 18. Pipe sewers (6,100 ft.), Lawrence, Kan. Aug. 9
Aug. 20. Cement, Pittsburg, Pa.....Aug. 2
Advertised, Eng. News, Aug. 2 to 16.
Aug. 20. Water-works system, Morganfield, Ky..Aug. 2
Advertised, Eng. News, Aug. 2 to 16.
Aug. 20. Paving, Toledo, O.....Aug. 2
Aug. 20. Plans for jail, Waukegan, Ill.....Aug. 2
Aug. 20. Dams, San Francisco, Cal.....Aug. 2
Aug. 20. Asphalt blocks, etc., Washington, D.C. Aug. 9
Advertised, Eng. News, Aug. 9 and 16.
Aug. 20. Sewer brick, Washington, D. C.....Aug. 9
Advertised, Eng. News, Aug. 9 and 16.
Aug. 20. Brick sidewalks, Crawfordsville, Ind..Aug. 9
Aug. 20. Bridge bonds ($100,000) Hamilton, O..Aug. 9
Aug. 20. Sewer materials, Baltimore, Md.....Aug. 9
Aug. 21. Sewers (27,485 ft.), Plainfield, N. J....Aug. 9
Advertised, Eng. News, Aug. 9 and 16.
Aug. 21. Paving bonds ($20,000), Marion, O....Aug. 9
Aug. 21. Highway (6 miles), Fortuna, Cal.....Aug. 9
Aug. 21. Sewers, Brooklyn, N. Y.....Aug. 9
Aug. 22. Drainage canal, Chicago, Ill.....June 28
Advertised, Eng. News, June 28 to Aug. 14.
Aug. 22. Pmpg eng. house, etc., New York, N.Y..July 26
Aug. 22. Sewer work, Cleveland, O.....Aug. 2
Aug. 22. Pipe, hydrants, etc., Rushford, Minn..Aug. 9
Aug. 23. Artificial stone walks, Cincinnati, O....Aug. 2
Aug. 23. Electric light plant, Estherville, Ia....Aug. 2
Advertised, Eng. News, Aug. 2.
Aug. 23. Highway bridge, Omaha, Neb.....Aug. 2
Aug. 23. Wharf repairs, Blackbeard Isld, Ga..Aug. 9
Aug. 23. Sewer bonds ($35,000) Hamilton, O....Aug. 9
Aug. 24. Fireproof building, Fairfax, Va.....July 26
Advertised, Eng. News, July 26 to Aug. 16.
Aug. 24. Disinfecting plant, Washington, D. C. Aug. 2
Aug. 24. Grading (12 miles), Wapakoneta, O.....Aug. 2
Aug. 25. Dredging, Wilmington, N. C.....Aug. 2
Advertised, Eng. News, Aug. 2 to 23.
Aug. 25. Sewers, Marietta, O.....Aug. 2
Aug. 25. Fireboat, Boston, Mass.....Aug. 9
Aug. 25. Sewers, Zanesville, O.....Aug. 9
Aug. 25. Well, etc., Austin, Tex.....Aug. 9
Advertised, Eng. News, Aug. 9 to 23.
Aug. 27. Canal, etc. (5 miles), Chicago, Ill.....Aug. 2
Advertised, Eng. News, Aug. 2 to 23.
Aug. 27. Bonds ($5,000), Lamberton, Minn.....Aug. 9
Aug. 28. Removing wreck, Boston, Mass.....Aug. 2
Aug. 28. Water-wks system, Cedar Rapids, Neb. Aug. 9
Aug. 28. Disinfecting plant, San Diego, Cal....Aug. 9
Aug. 31. Reservoir, Cambridge, Mass.....Aug. 2
Advertised, Eng. News, Aug. 2 and 9.
Sept. 1. Pipe, pump, etc., Honolulu, H. I.....July 19
Advertised Eng. News, July 19 to Aug. 2.
Sept. 1. Electric lighting, Portland, Ore.....June 21
Sept. 1. Electric lighting, Toronto, Ont.....Aug. 2
Advertised, Eng. News, Aug. 2 to 16.
Sept. 1. Electric light plant, Toronto, Ont.....Aug. 2
Advertised, Eng. News, Aug. 2 to 16.
Sept. 1. Pump'g engs., etc., Providence, R. I..Aug. 9
Advertised, Eng. News, Aug. 9 to 30.
Sept. 1. Water bonds ($10,000), Rushford, Minn. Aug. 9
Sept. 3. Bridge, Dillon, Mont.....July 5
Sept. 5. Operating machinery, Detroit, Mich...Aug. 9
Advertised, Eng. News, Aug. 9 to 30.
Sept. 6. Lock houses, Louisville, Ky.....Aug. 9

METAL MARKET PRICES.

LEAD.—New York: 3.55 to 3.6 cts. Chicago: 3.4 cts. St. Louis: 3.2 to 3.22 cts.

NAILS.—Pittsburg: $1.10 to $1.15 for wire, and 95 cts. for cut at mill, in carload lots.

BARBED WIRE.—Pittsburg: galvanized, $2.05 to $2.10; plain, $1.50; carload lots at mill.

FOUNDRY AND PIG IRON.—New York: $10.50 to $13. Pittsburg: $10.75 to $12. Chicago: $9.50 to $10.50.

TRACK MATERIAL.—New York: angle bars, 1.25 to 1.4 cts.; spikes, 1.5 to 1.7 cts.; track bolts, 2 to 2.1 cts. with square and 2.1 to 2.3 cts. with hexagon nuts. Chicago: angle bars, 1.25 to 1.35 cts.; spikes, 1.75 to 1.8 cts.; track bolts, 2.1 to 2.15 cts., with hexagon nuts.

RAILS.—New York: $24 to $25 at eastern mills and at tide water; old rails, $11 to $11.50 for iron, and $10 for steel; steel rails fit for relaying, $16 to $16.50; light rails, $22 to $24; girder rails, $21 to $24. Pittsburg: $24 for standard sections. Chicago: $25 to $27; old rails, $11 for iron and $8 to $10 for steel.

STRUCTURAL MATERIAL.—New York: beams, 1.4 to 1.5 cts.; channels, 1.4 to 1.5 cts.; angles, 1.3 to 1.35 cts.; tees, 1.5 to 1.6 cts.; universal mill plates, 1.25 to 1.35 cts.; steel plates, 1.35 to 1.4 cts. for tank, 1.4 to 1.5 cts. for shell, 1.6 to 1.65 cts. for flange, 1.75 to 2 cts. for ordinary firebox, 2 to 2.25 cts. for locomotive firebox. Pittsburg: beams, 1.3 to 1.4 cts.; channels, 1.3 to 1.4 cts.; angles, 1.25 to 1.35 cts.; tees, 1.4 to 1.5 cts.; universal mill plates, 1.2 to 1.35 cts.; steel plates, 1.2 to 1.3 cts. for tank, 1.4 to 1.45 cts. for shell, 1.5 to 1.6 cts. for flange, 2.5 to 3 cts. for ordinary firebox, and 3.35 to 3.5 cts. for locomotive firebox. Chicago: beams, 1.5 cts.; channels, 1.5 cts.; angles, 1.45 cts.; tees, 1.65 cts.; universal plates, 1.45 cts.; steel plates, 1.45 to 1.55 cts. for tank, 1.5 to 1.6 cts. for shell, 1.65 to 2.1 cts. for flange, 1.65 to 5 cts. for firebox.

INDUSTRIAL NOTES.

ASPHALT.—A company has been formed at Anaheim, Cal., for the purpose of manufacturing asphalt cement from the asphalt found in great quantities in the hills behind the city. D. S. Redican, of Los Angeles, is manager.

RAILS.—New or second-hand rails of 40 to 50 lbs. per yd. are wanted by C. P. Hammond, C. E., Americus, Ga.; the Clear Springs Phosphate Co., Bissell Block, Pittsburg, Pa., and the Atlanta Chert Paving Co., Atlanta, Ga.

SEWER PIPE.—A plant for the manufacture of cement sewer pipe is to be established at Appleton, Wis., by Reichert & Co., of Racine, Wis.——The Pierce Mfg. Co., of Bridgeport, Conn., has been incorporated by Howard Clark, F. A. Parsons and E. W. Dewhurst to make sewer pipe.

THE BALDWIN LOCOMOTIVE WORKS, Philadelphia, Pa., have sent six engines to Brazil. Some new machinery for the works has been made by the Capital Iron Works Co., of Topeka, Kan., from the designs of Mr. A. M. Baird, of the Atchison, Topeka & Santa Fe Ry. shops at Topeka.

THE SAFETY CAR HEATING & LIGHTING CO., of New York, states that the Pintsch gas plants which have been under construction at Cleveland and Detroit for some time, were completed last week. They will furnish gas to all the roads entering those cities, but principally to the Cleveland, Cincinnati, Chicago & St. Louis Ry. at Cleveland and the Michigan Central Ry. at Detroit, both of which roads have adopted the Pintsch light.

NEW COMPANIES.—Young Reversible Lock Nut Co., Hempstead, N. Y.; L. H. Young, F. J. Lancaster, and P. L. Ronalds.——Mutual Construction Co., Chicago, Ill.; $25,000; A. P. Williams, E. A. Meyer and Frederick Apel.——Pierce Mfg. Co., Bridgeport, Conn.; $10,000; sewer pipe; Howard Clark, F. A. Parsons and E. W. Dewhurst.——Washington Lighting Co., Camden, N. J.; $10,000, all paid in; James E. Hays, of Camden, N. J., and Charles D. Nicolai, of Washington, D. C.——Electro Gas Co., New York; $5,000,000 with $700 paid in; E. W. Dickerson, A. B. Proal and D. N. Moxon.——Richfeld Construction Co., New York; $100,000, with $500 paid in; Horace Moody, G. G. Jackson and A. M. Farnum.——Routh Safety Fender Co., Jersey City, N. J.; $150,000, all paid in; Oswald R. Routh, W. J. Russell and John E. Muller.

MUNICIPAL BOND MARKET.

New York, Aug. 7, 1894.

There have been no special features in the municipal bond market this week, as there were no notable sales by cities or towns, and the majority of the investors in this class of securities are away from the financial centers. This is shown conclusively in the August lists of bonds issued by a number of the leading houses, in which there are but slight changes in the offerings. The fact is that municipalities were so anxious to dispose of their bonds at good figures that all possible haste was made to offer them to the public before there was a drop in prices. The consequence is that most of the towns are now near their debt limit, or have issued all the bonds necessary, and there are no bonds in the market for dealers to buy. Prices remain firm, however, and brokers look at the present dullness as only temporary. An active market is anticipated with the return of financial people from the mountains and seashore. Among the offerings to be made this month is $118,000 of building loan 4s by Cambridge, Mass.; also $75,000 of sewer bonds. Bids will be received until to-morrow. Bids close Aug. 15 for Chicago's reoffer of $3,000,000 20-year 4s. All of the leading houses are much pleased with the amount of bond business transacted during July. It is considered one of the best months so far this year. One dealer says of July business:

"Notwithstanding all the drawbacks of the month, there has been a liberal investment demand for bonds, and Governments have been purchased freely throughout, the talk of another issue of 5 per cents. having failed to check the inquiry. The great ease in money and the limited demand for the same in the loan market, induced institutions and individual capitalists to buy for the purpose of employing their idle funds. This movement caused a great depletion in the floating supply of bonds and led to an advance in quotations. The demand extended from Governments to municipal bonds, the business in which assumed phenomenal proportions. Good prices were realized, and the preference given to this class of securities by investors reduced the stock in the hands of the dealers to a low ebb. Railway bonds started out well, and for a time the demand was fair and the market improved, but subsequently business fell off, particularly in the junior issues."

As furnishing interested parties an indication to the credit of various municipalities the following quotations of current offerings are appended:

MUNICIPAL BONDS.

	Price.
County of Flathead, Mont., Gold 6s	107½
City of Bartow, Fla., 20-year 6s	102
City of Pana, Ill., Water 6s	105½
City of Bethany, Mo., Gold 6s	105½
County of Park, Mont., Gold 6s	109½
City of Moscow, Idaho, Gold 6s	102½
City of Pullman, Wash., Gold 6s	103¾
City of St. James, Minn., 6s	107½
School District of Brainerd, Minn., 6s	108½
County of Brazoria, Tex., 6s	103½
County of Taos, N. M., 6s	101
School District No. 6, Kings Co., 6s	107¼
City of Harriman, Tenn., 6s	102
City of Toledo, O., 5s	111½
City of Omaha, Neb., 5s	111
City of Portland, Ore., Gold 5s	112½
City of Galveston, Tex., 5s	101½
County of Vanderburgh, Ind., 5s	109½
City of Cheboygan, Mich., 5s	104
City of Ogden, Utah, 5s	103½
City of Parkersburg, W. Va., 5s	103¾
City of Brooklyn, N. Y., 4s	110½
City of Marlboro, Mass., 4s	107
Town of Methuen, Mass. 4s	107
City of Waterbury, Conn., 4s	105½
City of Chicago, Ill., Gold 4s	104¼
City of Denver, Col., Public Imp. 4s	100

RAIWAY STOCK MARKET.

New York, Aug. 7, 1894.

Tariff and corn have been the chief factors in governing railway quotations during the present week and the honors, or dishonors, have been divided about evenly between them. For a long time the tariff has been such a conspicuous feature that industrials have rather monopolized the speculation on the New York Stock Exchange in a market of which nine-tenths consists of railway shares. Within the last few days, however, reports have been received from the principal corn-growing states, stating that the corn crop will be a total failure. Wall Street had had intimations for over a week of the bad condition the crop was in from the protracted drought, but it was thought the reports were greatly exaggerated, and some of the traders think they are yet. To-day, however, corn sold at 63 cents, the highest yet recorded, and a net advance of 8 cents. This, of course, gives the bad crop reports greater authenticity, though the surprise in corn is largely due to manipulation. Despite all of these evil forebodings, the granger stocks have withstood the shock remarkably well. That the grangers depreciated so little was largely owing to the fact that discouraging crop news was somewhat counterbalanced by bullish tariff news which had an effect of raising prices, and thus the grangers were benefited from sympathy. Burlington, Rock Island and St. Paul are the railways singled out as coming under the corn crop ban, and are consequently under bear hammers. A week ago Burlington was quoted at 73, Rock Island at 64¼ and St. Paul at 57½. To-day Burlington closed at 71¼ and Rock Island at 63¾, while St. Paul has scored a net advance for the week of 1¾ points. The question is among traders whether these stocks will be able to pay their usual rate of dividend, which is due at the end of this month. There has undoubtedly been considerable liquidation by holders of these securities in anticipation, from the corn crop news, of little or no dividend this quarter. But many of the stockholders are keeping their securities until the situation is thoroughly understood. With the exception of the stocks noted, there has been a material advance in all of the railway shares. While the statements of earnings that are coming in for the first six months of 1894, show a big decrease over those of 1893—some of the railways reporting the most disastrous six months in their history—the earnings for June are encouraging, inasmuch if they do not show an increase, they do show a diminishing in decreases. From what is reported so far of July, the statements are even more encouraging, though, of course, this cannot include any of the lines which were affected by the American Railway Union strike. The feeling at present is quite pronounced for higher prices in railway shares with the possible exceptions noted, and a week of active trading is looked for.

RAILWAY STOCK MARKET.

Railway stocks	Closing prices Aug. 7.
Alton & Terre Haute	29
Atchison, Topeka & Santa Fe	3¾
Baltimore & Ohio	72
Canada Southern	49
Chesapeake & Ohio	17½
Chicago, Burlington & Quincy	71⅛
Chicago & Northwestern	103⅞
Chicago, Milwaukee & St. Paul	59¼
Chicago, Rock Island & Pacific	63¾
Cleveland, Cincinnati, Chicago & St. Louis	36¼
Delaware, Lackawanna & Western	165
Delaware & Hudson	133¼
Lake Shore & Michigan Southern	129½
Louisville & Nashville	48⅝
Missouri Pacific	26⅞
Missouri, Kansas & Texas	13
Mobile & Ohio	20
New Jersey Central	109
New York Central	97⅝
New York & New England	6
New York, New Haven & Hartford	180
New York, Chicago & St. Louis, 1st pfd	62
New York, Lake Erie & Western	13⅞
New York, Ontario & Western	15
New York, Susquehanna & Western	14¼
Northern Pacific	3⅝
Northern Pacific, pfd	14½
Philadelphia & Reading	17⅞
Richmond Terminal	15⅝
St. Paul & Omaha	34
Southern Pacific	17¾
Texas Pacific	8⅞
Union Pacific	8¼
Wabash pfd	15
Wheeling & Lake Erie	10¼

BOSTON RAILWAY STOCKS.

	Aug. 7.
Boston & Albany	205½
Boston & Maine	147
Fitchburg	68
Old Colony	179

PHILADELPHIA RAILWAY STOCKS.

	Aug. 7.
Lehigh Valley	37½
Pennsylvania Railroad	48⅞